TRAINING FOR MAINTENANCE PERSONNEL IN TANZANIA

A study prepared for UNESCO

Prepared by

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Acknowledgement

The study was commissioned and funded by UNESCO. From the point of view of UNESCO the training of maintenance can best be tackled if maintenance specialisations are identified and stored somewhere for easy to access. It was the idea of Mr. F. Mayor – Director General, UNESCO - to establish a Centre of Maintenance Excellencies available within the country and between countries in the sub-region. *TechMa* is grateful, once again, to the Director-General for contracting them to undertake the study of the available competencies in institutions training maintenance personnel in this country as well as in the other participating countries.

TechMa is indebted to the personal interest shown by Dr M B Joof, UNESCO Representative and Head of the Dar es salaam field office in supporting the idea of the Center and in contributing to the elaboration of the objectives and instruments of the study.

Definitely the study could have not materialised without the co-operation of the Heads of the institutions studied who went out of their way, at times, even to change their programmes in order to accommodate the demands of the survey team. The subject teachers, likewise, were more than ready to spend time with the team sometimes boring them with repeating questions. We thank both of them for their professional understanding and co-operation.

The research instrument was made clearer after a thorough review of the questions by the research team. The comments *TechMa* obtained from the participants to the planning meeting (appendix 1), which was requested to review the questionnaire had helped greatly to improve the quality of the instrument. Nonetheless any weaknesses, which still remain in this report, are solely the responsibility of *TechMa*.

Lastly, but not least, we want to register our appreciation for the support the study team enjoyed from the Ministry of Science, Technology and Higher education, and in particular Mr. A. Ngororo, the Permanent Secretary, as well as the untiring interest shown by Mrs. N. Mnzava. the Secretary General of the UNESCO National Commission.

EXECUTIVE SUMMARY

1. Project Description

At its 153rd session, the Executive Board of UNESCO requested the Director General to allocate some funds from the United Kingdom contribution to the previous budget of UNESCO to the project of Culture of Maintenance. As a follow up to this proposal Tanzania, Kenya, Namibia and Zimbabwe put up a formal request to assist the Institute of Technology Management (*TechMa)* based in Tanzania to prepare for the establishment of a Center for Maintenance which the Director General of UNESCO is recorded to have proposed to establish in Dar es salaam.

This Sub-Regional Centre to be initially supported by the Dar es salaam UNESCO field office, is expected to provide a framework for the development of the Umbrella Intersectoral, Interdisciplinary and Interagency project on Culture of Maintenance.

To provide the Government with an informed set of alternatives for arriving at a final decision on the location of the Centre, the Institute of Technology Management proposed that the preparatory work for which the budgetary allocation from the UK contribution could be used was to study the situation prevailing in the country as well as in the other three countries: Kenya, Namibia and Zimbabwe as regards the teaching of maintenance technicians. Specific questions guiding the study are:

- to identify the institutions teaching and training maintenance technicians
- to examine their programmes
- to assess their strengths and weaknesses as well as their entrepreneurship in a competitive world
- to propose a set of alternative ways and means for improving the programmes and the teaching of maintenance in the institutions and countries covered in the study

The overall objective of the study includes establishing a database for the eventual development of what UNESCO calls a Maintenance network (Maint – Net) which will assist institutions within the sub-region to share experience and exchange resources: information and expertise. It is also envisaged that a clearer understanding of the situation pertaining to the teaching and training of maintenance will help in understanding better the extent of the complexity of the broader policy question of culture of maintenance.

2. The Major Findings

In general the findings of the survey seem to have adequately responded to the questions which the study set out to get answers for. The following observations are particularly worthy of highlighting.

- It is interesting to note that there is, in fact, maintenance training in the country, a programme which has existed as long as the existence of the technical colleges and the Universities. However, the weight given to the subject matter varies with institutions.
- Almost all institutions covered in the survey teach maintenance as a general set of subjects. Except for the Agriculture Engineering Department there is no specialization as there could be in the National Institute of Transport or the TANESCO Training Institute. There is, however, an intention of building specialization in maintenance of scientific equipment at the department of Electrical Engineering of the FOE at the University of Dar es Salaam.
- The emphasis in the teaching methodologies employed is on the provision of maintenance skills. There is no programme which addresses the intellect, the attitude or the mindset to provide to the students a deeper understanding of preventive maintenance.
- Furthermore, a good number of the trainers have only the academic knowledge of the subject matter plus the teaching experience. Very few have the practical or field maintenance experience.
- Likewise there is no link in the teaching between theory and practice. Students are not exposed to field/practical experience.
- A serendipitous finding worth mentioning is the apparent lack of interest in the market, especially the private sector in having their staff train in maintenance because, it is alleged, it may end up being a source of loss making to the enterprise. This has yet to be established in a study on the market needs of maintenance technicians.
- There is a scatter of strengths as well as weaknesses available in the eight institutions surveyed. The DIT seems to have stronger concentrations of the factors used to measure strengths than the others do.

3. Limitation of the Survey

As mentioned the survey inadvertently left three important maintenance training institutions in the field of motor vehicle maintenance; electrical equipment; and in hospital equipment maintenance.

Secondly, the study focussed only on well known public institutions which are known to train maintenance technicians. It is acknowledged that there are many private enterprises which undertake the training in maintenance at artisan level, mostly in motor vehicle maintenance, repair and information technologies.

4. Major Recommendations

The major recommendations put forward by the survey team are those addressed to the government which include the following:

There is need to clarify, to the Technical Colleges, the government policy which allows them to initiate changes/improvements in the syllabi in response to market demands and technological developments.

Efforts have to be made to institute sustainability of programmes in the training institutes.

A firm decision has to be made as to the mission, financing and location of the Center for maintenance.

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Abbreviations and Acronyms

AATP	Arusha Appropriate Technology Programme
ADE	Advanced Diploma in Engineering
AGRIC&LP	Department of Agriculture and Land Planning. Sokoine University of Agriculture
ARCH	Architecture
ATC	Air Tanzania Corporation
AUTO	Automotive
BICO	Bureau for Industrial Co-operation
CAMARTEC	Centre for Agricultural Mechanisation and Rural Technology
CE	Department of Civil Engineering
CPE	Department of Chemical and Process Engineering
DIT	Dar es salaam Institute of Technology
DRVTSC	Dar es salaam Region Vocational Training and Services Centre
E&T	Department of Electronic and Telecommunications Engineering
EE	Department of Electrical Engineering
EEC	European Economic Commission
FoE	Faculty of Engineering
FTC	Full Technician Certificate
GNP	Gross National Product
KTC	Karume Technical College
ME	Department of Mechanical Engineering
MMS	Meida Maintenance Services
MTC	Mbeya Technical College
PM	Preventive Maintenance
R&D	Research and Development
RWRI	Rwegarulila Water Resources Institute
S&LB	Department of Science and Laboratory Technology
SIDO	Small Industries Development Organisation
SME	Small and Medium Enterprise
SUA	Sokoine University of Agriculture
TAMTU	Tanzania Machinery Testing Unit
TCA	Technical College Arusha
TEMDO	Tanzania Engineering Manufacturing and Design Organisation
TIRDO	Tanzania Industrial Research and Development Organisation
UCB	University Consultancy Bureau
UDSM	University of Dar es salaam
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
VETA	Vocational Education and Training Authority

PART ONE: STUDY CONTEXT

This part provides the context of the main issues the study examines. It is organised in two chapters. The first chapter, "Introduction", primarily outlines both the background and objectives of the study. The second chapter, "Maintenance and Development" defines maintenance in the context of this study, and examines the relationship between maintenance and development. Based on findings of the recent studies, it gives a brief descriptive account of the experience of maintenance in a few selected Tanzanian institutions.

CHAPTER I

INTRODUCTION

1.0 BACKGROUND TO THE STUDY

Few analysts and observers will deny the importance of maintenance to development in developing countries. That importance is growing very fast in recent years. A number of factors contribute to this. The increasing technical sophistication and the high costs of equipment and machinery used in modern factory based industries and infrastructure facilities in many such countries compel timely, and efficient maintenance management. Likewise, full deployment of 'intelligent' management techniques[1] for competitive growth in many of the modern installations in the Developing world presupposes a minimum of plant stoppages and downtime. Both these factors compel a heightened need for proper and efficient maintenance in developing countries if development on a sustainable and competitive basis has to take place. Yet, and sadly enough, the evidence there is suggests that maintenance is wanting in a great many countries in Developing world[2].

This study seeks to contribute to the understanding of the problem of lack of maintenance culture (UNESCO) or maintenance mindedness (UNIDO) in the economies of developing countries. Amongst the many factors which may contribute to this malaise is the training (production) of maintenance technicians by the training institutions.

Is there any training of maintenance technicians? Which are the institutions in the sub-region that train maintenance technicians? How are they trained? Who trains them? What are the profiles of the institutions and the trainers? These are some of the questions which are asked in the study.

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[1] Such techniques include Kanban (just-in-time-jit), agile and flexible manufacturing, total quality control management, lean manufacturing and a whole range of techniques deployed within continous improvement programmes.

[2] This is well explicated in the records of discussions of participants from developing countries to the UNIDO symposium held in Duisburg in 1970.

Maintenance problem is not only a chronic problem in developing countries, particularly in Africa, it is also a problem which has had retrogressive effects to development efforts. Examples of unproductive investments due to poor maintenance abound. Even though we do not have as yet studies providing figures of costs (gross or net) of non-maintenance, mere observation can point to the high costs, to the economies, arising from poor maintenance of highways, urban facilities (roads or streets, bridges, sewage, drainage systems), public buildings such as schools[3], hospitals etc.

A major non-maintenance cost, which was underlined by a UNIDO organised symposium in November 1970, is the hindrance to (industrial) development and the waste and misuse of capital. The workshop observed that in one case 85 percent of a fleet of tractors became idle and unserviceable only two years after they were imported because of lack of maintenance[4] . Bavu et al. in their book ***Culture of Maintenance for Sustainable Development in Tanzania*** call the attention of the leaders to the dilapidated (public) houses owing to lack of maintenance and repair; impassible roads left to deteriorate to a state of disrepair hence needing more costly overhauls; underserviced and under-maintained motor vehicles; discarded equipment at places of work, schools, and even at home. All this in totality adds up to a situation of acceptance of non-maintenance as a way of life: what the UNIDO symposium had called lack of 'maintenance mindedness'.

As it is obvious from the two attempts referred to above the problem of non-maintenance is acknowledged by many as frustrating to development efforts. The causes are many. Those listed by UNIDO symposium and by Bavu et al., as well as by the symposium organised by the EEC include the following:

- lack of awareness of the importance of maintenance,

importation of many varieties of devices requiring different types and levels of technical knowledge skills, expertise, and spare parts,

- inadequate provision of maintenance technicians,
- inadequate allocation of resources,

[3] A DANIDA. Evaluation Report on the School Maintenance Project Tanzania points out the problem of costs of non-maintenance of schools in Tanzania pp.44/45. Aside from the financial costs which are difficult to quantify there are other costs, amongst which are fall of quality of education, morale of teachers and the demise of awareness of the importance of maintenance.

[4] Maintenance and Repair in Developing Counties - UN New York 1971

- unfavourable policies,
- poor flow of technical information between suppliers and users of equipment,
- maintenance given low profile in the enterprise objectives.

It should be pointed out that lack of awareness of the importance of maintenance and the low profile given to maintenance are some of the important factors explaining the attitudinal aspect of the problem of maintenance in developing countries. Many governments in developing countries prefer purchasing new equipment and machinery or building new roads etc. rather than providing for maintenance of the old. On this point, a recent UNIDO Mission (1991:48; 1994:48) carried out in Tanzania observes:

> *"one final human resource problem to which it is worth drawing attention is the national attitude to the maintenance of facilities and machinery. The Tanzanian attitude to machinery and equipment is to buy it, use it, and abandon it when it breaks down. Maintenance has been relegated to the back banner"*

Compare the situation with the importance given to maintenance in the industrialised/developed countries. The United States industries spend between 15% and 40% of the costs of goods produced on maintenance. The Federal Republic of Germany spends 10% of its GNP each year on maintenance. From this data Mjema argues that maintenance has a high potential of reducing the costs of production and increasing profitability.[5]

Just as there are many probable causes of poor or lack of maintenance of facilities and infrastructure, there are also many suggested solutions. UNIDO symposium has divided them into three: those recommended to the developing countries, to the developed countries (equipment manufacturers) and those addressed to UNIDO itself. Although the symposium underlined the need to develop maintenance-mindedness the prescriptions given to the three groups are purely technical, functional and operational.

To some extent the same can be said about DANIDA Project. The project undertook the rehabilitation of Secondary schools building and the training in preventive maintenance[6].

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[5] Mjema, E. A Simulation based Method for Determining Personal Capacity Requirements in the Maintenance Department, Shaker Verlag, Aachen. 1998. p.1

[6] Evaluation Report: The School Maintenance Project, Tanzania. DANIDA, 1992.

The conclusion of the impact evaluation suggests that except for the few secondary schools "with strong traditions" and some teachers training colleges, the vast majority of students in secondary schools and teachers training colleges revealed very little knowledge on the topic i.e. preventive maintenance.

Hence the problem still persists: that of building in the minds of men and women a sense of care and valuing property, not on an ad-hoc manner but as a way of life. It involves the building of a mind that is consistently conscious of the need to maintain the condition of things as they were when new. This is what culture of maintenance is all about and the question that UNESCO has set to address.

1.1 Culture of maintenance and the training of maintenance technicians/engineers.

Changing attitudes of the people in favour of maintenance can only produce the required results if at the same time the people are empowered with the necessary resources including technical capabilities to undertake maintenance. It is the enabling environment which is a necessary intervention for attitudes building or changing. The training of maintenance technicians for which there is a provision in UNESCO Programme and Budget, 1997-98 as approved by the 29th session of the General Conference seeks to contribute to the development or strengthening of this enabling environment for the building of a Culture of Maintenance.

As pointed out above maintenance problem as identified by the UNIDO, EEC and TechMa symposia is a global problem affecting most of the developing countries and affected to some extent by the technologies developed by the scientifically and technologically more advanced countries. Its solution logically requires a global approach or the involvement of all. For reasons of manageability and effectiveness UNESCO General Conference has requested the Director General to support or develop activities in African countries as a starting point, and he has decided to work with Tanzania as a centre for the programme and include Kenya, Namibia, Uganda and Zimbabwe. The present study which has focused on Tanzania is intended to develop efficient tools and experience which may be used in conducting similar studies in the other countries.

At this point it will help to clarify the relevance and place of maintenance technicians or engineers training in the overall problem of maintenance mindedness.

As it has been pointed out elsewhere, maintenance culture is a product of the intervention of a number of activities which can be grouped into three levels:

Preservative maintenance.

This is the social cultural based set of variables and activities:

(i) Awareness of the importance of maintenance. This can be caused by lack of scientific or technical knowledge about the design parameters of the object or how the object works and how it can be made to retain its efficiency by regular maintenance.

(ii) Not valuing the object used. This state occurs when either the user is ignorant of the usefulness of the object in use, especially when one is not used to such an object or when one does not own the object and hence it is alien.

Activities pertaining to preservative maintenance include careful handling and care in storing as well as keeping the object clean from any foreign bodies. It means attaching value to the object by the user. To instill this behaviour in the individual requires a well thought out programme from childhood – pre-primary, primary, secondary up to post-secondary.

The dictum for this is "Leave it as you found it" or as one had it on a public toilet wall "Please leave me clean, I will not tell any one what I have seen". What is suggested by the dictum is that preservative maintenance embraces the entire community or users, which is more broad based than preventive maintenance which is confined to the maintenance technician.

Service maintenance or preventive maintenance is technical. It applies to trained personnel, involving constant check-up and abiding to the maintenance manual. The dictum is "A stitch in time saves nine".

The third level is that of **Renovative maintenance**.

Again this is a technical level and involves experts in the field with the dictum "shed your skin and be young".

Obviously attitude building is established at level one - the preservative maintenance, but there is also attitude involved in the dictum stitch in time saves nine as well as the last level. Being conscious and appreciative of the importance of both service and renovative maintenance is in fact a cultural question. It is also obvious therefore that the non-cultural aspect of training for technical and skills development though an important ingredient constitutes only a small portion of a culture of maintenance.

1.2 OBJECTIVES OF THE STUDY

This study has two phases. Phase one whose report this is examined the training of maintenance personnel in a number of institutions in Tanzania. The purpose of this first phase of the study has been to obtain data on the institutions to assist the government in having an informed decision on the choice of a Maintenance Center and on the National Focal point. It has also sought to test the instruments for obtaining data from the other participating countries for launching the planned Maintenance Network for the sub-region.

Within the above-mentioned broad objective, the Tanzania case of the study has a number of specific objectives. These include:

(i) To compile and develop an inventory of institutions which conduct maintenance training in Tanzania

(ii) To examine the nature and content of maintenance related programmes in place in training institutions surveyed.

(iii) To compile and develop a list and profile of maintenance trainers in the institutions studies.

(iv) To enumerate the strengths and weaknesses associates with maintenance training within the institutions

(v) To develop a data base in Tanzania in respect to maintenance programmes, maintenance trainers and maintenance institutions in the country. In turn the database will provide a basis for networking amongst the institutions studied and later on between institutions in the participating countries.

This phase of the study, the Tanzanian part, is intended to act as a test of the survey instrument used whose results will be examined by a sub-regional meeting to determine its efficacy and appropriateness as a tool to be used in conducting similar studies in the sub-region. The results from all the four country studies will be used to develop a solid basis for the establishment of national and sub-regional network of maintenance training institutions for the purpose of exchange of experience and expertise in maintenance.

1.3 SCOPE AND COVERAGE OF THE STUDY

The Tanzanian study covered the following institutions:

(i) The two universities, both of which have active programmes for training engineers: the University of Dar es Salaam (Faculty of Engineering) and the Sokoine University of Agriculture. The former trains mechanical, civil, electrical and chemical and process engineers. The latter trains Agricultural Engineers.

(ii) The second group of institutions covered is Technical Colleges or Institutions training diploma-engineering and full technician certificate holders. These were the Dar es Salaam Institute of Technology (DIT), Technical College, Arusha (TCA), Mbeya Technical College (MTC) and Karume Institute of Technology in Zanzibar.

(iii) All engineering R $ D and Consultancy institutions which organise short courses in maintenance. These include the Institute of Production Innovation (IPI), Tanzania Engineering, Manufacturing and Design Organisation (TEMDO), Tanzania Industrial Research and Development Organisation (TIRDO), Bureau for Industrial Cooperation (BICO) at the University of Dar es Salaam, and Meida Maintenance Service (MMS).

(iv) One typical Vocational Training Center which trains artisans in technical areas relevant to maintenance such as electrical installation masonry, fitter and turner, metal fabrications, motor vehicle mechanics etc., the Dar es Salaam based 'Dar es salaam Regional Vocational Training and Service Centre (DRVTSC) as an example of the rest in the country.

(v) Umbrella/professional organisations responsible for overseeing and coordinating engineering as a professional group; and the vocational training coordinating institution, Vocational Education and Training Authority (VETA).

It has to be admitted the criteria used in selecting the institutions for the study was rather ad-hoc. It relied mainly on what *TechMa* Director knew or remembered. From the knowledge and memory the list was prepared and through to have been exhaustive. Since it appeared to be a short list it was thence decided to include all the institutions in the survey.

It is regretted that the list did not include the National Institute of Transportation and the TANESCO Institute, both of which are specialised in training of maintenance personnel in their areas of specialisation. Likewise, we did not at this stage, as indicated earlier include the end users of the product of the maintenance training institutions - the industries (or the demand side of maintenance). We thought that the identification of maintenance training needs is a major problem and deserves a separate study.

1.4 METHODOLOGY OF THE STUDY

UNESCO has been working closely with researchers in the Institute of Technology Management *TechMa* in the conceptualisation of the problem of Culture of Maintenance since its introduction into the UNESCO vocabulary. When UNESCO finally decided to examine the place of maintenance technicians training in the problem definition, *TechMa* was contracted to undertake the survey. The survey team prepared the test questionnaire which was later presented to a select group of stakeholders for its comments and improvement - both for relevance and effectiveness. The inputs obtained from the stakeholder group (Appendix 3)[7] greatly helped to improve the final version of the questionnaire.

The questionnaire was then sent to each of the surveyed institution and the institution was invited to a round table discussion regarding the questionnaire with the research team. The institutions participating to the round table discussion consisted of mainly the heads of the institutions and the maintenance subject teachers.

[7] See Proceedings of the Planning meeting for the study in Appendix 3.

At the end of the study a preliminary draft report was prepared and sent to the participating institutions for review. Copies of the report were also sent to the identified focal points of the envisaged sub-regional Maintenance Network. These two groups of stakeholders were invited to a review meeting which had three main objectives:

a) To review the draft report of the study for the final version
b) To introduce the idea of the sub-regional Maintenance Center and to meet the identified focal points from the participating countries.
c) To highlight the important questions in the questionnaire used in the study for collecting data from the participating countries which will form a base for the envisaged Maintenance Network.

The proceedings of this review meeting are appended at the end of this report as Appendix 4.

1.5 STRUCTURE OF THE REPORT

Apart from opening chapter the rest of the report is organised in four chapters. Chapter two, '*Maintenance and Development*', sets out to define maintenance and culture of maintenance in the context of this study. It also examines the relationship between maintenance on one hand and development on the other. Chapter 3 titled, *Institutions Training Maintenance Personnel*' is basically a description of the institutions surveyed in the study offering maintenance training courses. The chapter also attempts a simplified characterisation of the maintenance training institutions. Chapter four '*Maintenance Training curricula and Programmes*' is by all purposes and intents a description of the maintenance programmes and curricular in place in the training institutions surveyed, and about those who carry out the training programmes (i.e. the profiles of the trainers. Chapter five *'Capabilities and weaknesses in Maintenance Training'* provides both a descriptive and analytic account of the strength and weak points related with maintenance training in the institutions covered in this study. And the final chapter, 'Summary, Implications and Recommendations summarises the main findings of the study; and based on the findings proposes a number of recommendations in respect of future activities (of a policy and research nature) in respect to maintenance curricula design and mainstreaming, and maintenance training for competitive and dynamic plant performance.

CHAPTER TWO

MAINTENANCE AND DEVELOPMENT

2.0 Introduction:

Various strands of development thought attach special importance on maintenance in the context of development. Efficient maintenance management is seen as the key to continuos improvement and competitive performance of a productive unit. This is a recent development perspective. The recent strands of development thought also suggest that efficient maintenance management presupposes availability of various types and qualities of capabilities in-house and around the production facility in question.

This chapter will first outline the meaning of maintenance. It will then indicate the relationship between maintenance on the one hand and improved performance (or development) on the other. It will also give maintenance status in Tanzania to date.

2.1 Maintenance – towards a working definition

There have been various attempts to define such a rich and value loaded term as maintenance. Some of these attempts include for instance, Clifton, 1978; Kelly and Harris, 1978; UNIDO, 1971; 1975 amongst others. However, in the Tanzanian situation, we do not have as yet a standard and nationally adopted working definition of the term – though this is highly desirable and compelling at this point in time. Despite this and in the context of this study, the term maintenance will be taken to mean in the same way as in Kelly and Harris (1978:4);

> *'..... as a combination of actions carried out in order to replace, repair, service (or modify) the components or some identifiable grouping of components of a manufacturing plant so that it will continue to operate to a specified availability for a specified time'.*

It is also important to bear in mind of the fact that maintenance has two intimately related aspects or dimensions: the technical (or socio-cultural) dimension on the other. These dimensions are briefly described below.

2.1.1 Techno-engineering dimension of maintenance

Looked from a techno-engineering perspective maintenance is usually seen as involving:

(i) oiling and lubricating plant machinery, equipment; rehabilitating roads, buildings and other types of physical infrastructure

(ii) tightening up of bearings, bolts and nuts of equipment and machinery when they loosen

(iii) replacing and 'fixing' a broken and damaged part or component of equipment, machinery, or of any form of artefact.

(iv) creation of physical facilities within and around plant premises for the performance of (i) – (iii) as above. Such facilities often cited include workshops, repairshops, foundry shops etc.

(v) developing technical (but largely engineering) skills and expertise relevant for performing maintenance related jobs and functions. Such skills include those which have to do with forging, machining, cutting, casting, fabrication and the like. In turn, these skills and forms of expertise are built up through a variety of methods e.g. formalised training programmes; learning – by – doing programmes, apprenticeship schemes and so forth.

Quite evidently, oiling and lubricating; tightening of bearings, bolts, nuts etc just like 'fixing' and replacing broken and damaged parts of equipment and machinery relate to particular aspects of maintenance. Some parts and components of a given piece of machinery or equipment have to be fixed or oiled or lubricated or indeed tightened up to perform well; and this is maintenance – but only part of it. Furthermore, this is inherent; and is part and parcel of the ongoing operation and management activities of a production facility. An overwhelming proportion of the studies[8] on maintenance to date relate to this technical and

[8] Amongst the many studies include Clifton (1974); Kelly and Harris (1978); and UNIDO (1971; 1975)

engineering dimension of maintenance. This particular perception of maintenance has been observed to be associated with a number of significant flaws. The main ones to these have been sucinctly described in Mlawa and Bavu, (1997:10):

> *First it is simplistic, narrow, and short-term. It focuses on the short-run and static issues of repair works and activities (e.g. setting up and improving repairshops, workshops, developing and upgrading engineering and related technical skills, experience, etc.) in existing repairshops, and workshops, etc. in-house production facilities and so forth*
>
> *Second, it is uni-dimensional. It focuses on single aspects of maintenance. For example, it looks at maintenance in terms of building a capability relevant for producing spare parts, replacement parts, components, etc. It also looks at building a human 'hands-on' capability for the efficient handling of routine repair works; tightening up loose bolts, nuts, bearings, oiling and lubricating machine parts, components, and so forth.*
>
> *Third, and perhaps most important, it misses out a cultural, social, managerial and organisational aspect of maintenance. For example, the perspective leaves out issues such as how does one build up, over time, the attitudes, values, perspectives and 'empowerments' in a plant or organisation which attaches significance and importance to maintenance for development? How does one plan for, organise and manage repair and maintenance facilities and activities required for efficient plant operation and management? How does one plan, organise and manage stocks of inventories of spare parts, replacement parts, machine components and maintenance materials, etc. within a plant? And so forth* (emphasis ours).

2.1.2 Socio - cultural dimension of maintenance

Very recent studies on maintenance and development[6] suggest that there is a deep and substantial socio-cultural dimension within maintenance. The socio-cultural dimension of maintenance or simply referred to as culture of maintenance is herein defined as:

> *.....that way of life in society which includes a collection of ideas and habits learned, shared and transmitted from one generation to another and how they are preserved, kept and sustained. It also includes the habits of keeping clean and maintaining instruments, infrastructure, etc.*

Bavu et al (1997) define Culture of maintenance as:

> *.... The way the society values and ascertains the prolongation of the life of the artefacts or facilities they use for their development through routinised care. It*

[6] See amongst others Mlawa, 1992; Bavu et al 1997.

means a sense of social or public regard for maintenance which in turn requires the understanding and enhancement of the life of the artefact and facilities used by members of the society .....

Hence, culture of maintenance is a two dimensional concept. As a social development concept, it is a product of the valuation of the things used with the knowledge of their technical composition. It is the societal way of life having to do with care of and attachment to what members of the society use in their daily lives. This constitutes one dimension of culture of maintenance. The other dimension is technological. It is the routinisation and habitualisation of the activities of maintenance

Culture of maintenance thus constitutes of a set of attitudes, beliefs, abilities, 'empowerment' etc within and around a society, which appreciate, value and attaches significance and importance to infrastructure and other forms of artefact. Put in somewhat differently, culture of maintenance is, as Mlawa and Bavu (1997:19) put:

---- the cultural basis of maintenance: the appreciation, the attaching of value and having regard to maintenance by a whole community, society etc.

Clearly, and from the above, it is evident that culture of maintenance or the socio-cultural dimension of maintenance is a much richer, yet, fluid concept. And in very significant ways the concept:

⇨ integrates the socio-cultural aspects intimately with the technical, economic and organisational dimensions of the concept.

⇨ goes well beyond operational activities taking place at the shopfloor level of a production facility (e.g. repair works, oiling, lubricating etc,) to encompass all the activities within the entire production process in the production line. Maintenance, seen in this perspective is not thus an activity localised and confined to the shopfloor level.

⇨ recognises that maintenance planning takes place several stages before ongoing operation and management begins. Therefore, planning for plant maintenance must begin right at the stage of plant or project conception, design and preparation through to project implementation, operation and management. Maintenance should not be seen as an 'after thought' or an 'add on' or as something which is 'plugged' into the production process during the ongoing and operation phase of facility.

⇨ recognises that it takes efforts, time, allocation of resources and a commitment to design and put in place plans, schedules and strategies to build up efficient maintenance operations in a plant. Such strategies and plans may be geared towards:

(i) making sure that clauses relating to the supply of spare parts, components and maintenance facilities are included in the equipment purchase agreements right at the stage of project conception, design, preparation and implementation; and that suppliers do actually supply these in the amounts and qualities and at the times specified and agreed upon in the technology supply/purchase agreements.

(ii) clauses relating to training, apprenticeship and learning-by-doing programmes and schemes for building up local maintenance skills, knowledge, expertise and experiences are included in the 'equipment supply' contracts and that these are effected;

(iii) development of a local capability for the supply and production of spare parts, components and replacement parts and ensuring that these are provided for in the contracts for setting up new production facilities, and that this is actually done during the course of project implementation.

(iv) developing, nurturing and accumulating a set of ideas, attitudes, abilities and 'empowerment' which attach significance to property, artefact and to the proper maintenance of these.

(v) recognises that maintenance is an essential aspect of a facility's business and growth strategy; and thus, efficient maintenance management is a major source of dynamic comparative advantage, competitive performance and sustainable development of a facility.

2.2 Factors determining Maintenance Performance

A number of factors determine maintenance performance in a production facility. The main ones are enumerated below.

2.2.1 Capability for forging and fabricating spare parts, machine parts, components etc.

It has been repeatedly suggested that availability or otherwise of facilities such as foundryshops, repairshops, workshops etc. within and around producing firms influence the state of maintenance in a producing unit. Existence of facilities such as these in good working condition is essential for efficient maintenance. Likewise, lack of such facilities, as is often the case in the majority of plants in a great many Countries in sub Saharan Africa, affects negatively, the state of maintenance.

2.2.2 Skills, expertise and experiences for maintenance

Human capital in the form of skills, expertise, knowledge, experiences etc, is an important factor influencing the sate of maintenance. It is often argued that efficient execution of maintenance jobs requires availability of competent skills, expertise with the experience of handling those functions. These functions include - identifying the parts and equipment which need maintenance, doing the actual maintenance work required, ordering for the maintenance parts etc. It is often suggested that many countries in sub Saharan Africa are deficient in these kinds of skills and experiences. This in turn contributes to poor maintenance performance often experienced in these countries.

2.2.3 Maintenance plans and schedules

Design and execution of maintenance plans and schedules is critical to the efficient maintenance of a plant. It is often argued that part of the explanation to the excellent maintenance performance in plants in advanced countries is the design and subsequent execution of plans and schedules for maintenance. Conversely, it is often argued that the generally poor maintenance performance in many developing countries is explained, partly at least, by the absence of clear and good maintenance plans and schedules. And where they do exist, they are not out in place at all.

2.2.4 Stocktaking and inventory of spare parts, replacement parts etc.

Efficient record keeping of what kinds and volumes of spare parts, machine components etc a plant requires at any one moment is crucial for efficient plant operation and its sustenance. Inaccurate and improper systems and procedures for spare parts inventory control and management is most likely to lead to unnecessary shortfalls of some parts and 'oversupply' of others at the same time. Most sub Saharan Countries have limited capabilities and systems for stock taking and inventories of spare parts, replacement parts etc needed for the efficient handling of plant maintenance.

2.2.5 Inadequate incentives to maintenance personnel

An attractive and adequate incentive package and system to those who handle maintenance jobs in a plant is an important factor determining the quality of maintenance in a given plant. It has been asserted by many that the incentives given to maintenance staff in very many production facilities in sub Saharan Africa are inadequate. The incentive packages are even more inadequate when compared to those given to personnel working in other departments in the same plants - viz. finance, personnel management, public relations, marketing and so forth. This obviously works as a disincentive to their work and ultimately impacts negatively to maintenance performance in general.

2.2.6 Attitudes and behaviour towards maintenance

Positive attitudes, behaviour and actions of a community or a society in favour of maintenance (maintenance mindedness) forms a key determinant factor for efficient maintenance performance of a productive structure. It has been repeatedly suggested by several authors in recent years that a low development level of maintenance – mindedness (or simply culture of maintenance) in many communities and productive structures in much of sub Saharan countries constitute a major constraint to effective maintenance performance and hence to sustainable development in the sub region.

2.3 Relationship between Maintenance and Development

Is maintenance related, in any way, to development? If so, in which ways. These are some of the questions we shall attempt to answer however briefly in this section. It is perhaps important to underscore the ultimate objective of any productive activity. An entrepreneur owns and engages into a production process in order to benefit from the venture: to make profits. In turn, this calls for:

- Efficient organisation and co-ordination of the productive activities within the enterprise;

- Efficient and effective mobilisation of productive resources (e.g. raw materials, labour, finances, energy, etc.) for production.

That is to say, the enterprise must operate in the most efficient and economic manner. The enterprise must be competitive – cost and quality wise. This in turn means that there should be no unscheduled and unnecessary stoppages and downtime in the plant. This thus places great importance on maintenance in the context of enterprise or corporate development in particular and economic development of a country in general.

The experience of the development process worldwide suggests that both sustainable and competitive development of a productive unit depend not just on the scale and quality of its capital stock - although this is clearly important. Rather, it critically depends on efficient utilisation of the plant, equipment and capital stock in place through efficient maintenance management. To a productive unit, efficient maintenance forms an important source of various kinds of benefits and competitive advantages:

(a) extending the useful life span of machinery and equipment;
(b) ensuring the optimum availability of installed equipment for production;
(c) ensuring instant operational readiness of equipment for emergency use;
(d) ensuring the safety of personnel;
(e) improving equipment and capital efficiency and productivity in general through reduced breakage and down time;
(f) reducing overtime pay for maintenance staff
(g) minimising product rejects, spoilage, and ensure better quality standards
(h) postponing or eliminating cash outlays for premature replacement of a plant or piece of equipment;
(i) reducing stand-by equipment needed thus reducing capital stock investment, minimise maintenance cost through labour and material; and
(j) ensuring greater safety and improved protection for the plant leading to lower compensation to insurance costs.

Corollary, poor or inadequate plant maintenance often results in economic losses through lower efficiency of installed machinery, equipment and facilities due to high levels and rates of stoppages and downtime; poor and low quality of products and services and high costs of

production. Poor maintenance also leads to faster deterioration and consequently to shortened physical lifetime of installed equipment – itself constituting a waste of capital and resources. In resource poor developing countries, this problem can easily lead to perpetual underdevelopment and poverty.

2.4 Training of maintenance technicians and the culture of maintenance

Earlier on, it was hypothesised that training of maintenance technicians may have a bearing on the malaise of maintenance, and therefore on the sustenance of development. It is important at this juncture, to note that all cultures are sustained through their transmission from one generation to the other. Some form of teaching or training effects this cultural transmission. Any form of doing things, by a society, blacksmithing, architecture, singing, music, dancing, cattle ranching, weaving, cooking, food preservation, building etc as well as the way people take care of their things is acquired or learned from others by education, formal or informal.

Training therefore, as a form of imparting knowledge to enterprise workers or would be enterprise workers, is a major resource in the development of the enterprise. As one Tanzanian Executive said to his Staff Council "if you do not value knowledge (training) try Ignorance". What this challenge is saying is that training as an investment has to be budgeted and prioritised. It means choice which may leave out other demands of the enterprise. If the choice is not in favour of the training or if training is considered too expensive then working with untrained or unknowledgeable workers may cause a lot more damage to the enterprise than the cost of the training.

The changing world of today poses many challenges to the world of work. Universities and other institutions of higher learning are continuously faced with these challenges including initial and continuing education. Report to UNESCO of the International Commission on Education for the Twentieth Century observed that the need for people to return to education in order to deal with new situations arising in their personal and working lives, is as old as enterprise organisation but is becoming stronger as the challenges of new technologies are increasing. While this is true of all societies as noted by the report, it may be more so for

societies that are recipients of technology developed and transferred from the advanced countries.

Training to become knowledgeable of the scientific and technological nature of the equipment to work with is an important ingredient in the development of a mindset which is appreciative of maintenance. Maintenance mindedness (the lack of it) is a global problem in the sense that it affects in one way or the other all. Its solution, on the other hand, may not be so global. Since there are many different types of technological innovations and scientific faculties, maintenance requirements and maintenance knowledge for each will also be different, and so therefore is the required training. Hence the question to ask is which training for what? And how?

If the unchallengeable thesis is accepted that there are few instances where employees (serving and new) are fully prepared for the specific tasks they are assigned, if we accept the inevitability of change in programme content, and therefore job content, if we accept the need to keep up with developments in technology of any occupation, then it is easy to see that formal devices for sharpening and directing skills and performance are essential to all modern enterprise.

A sense of labour market therefore is of paramount importance to maintenance training institutions programme designs. For universities, Faculty of engineering etc therefore, flexibility has to be provided between steering the best students towards research and towards industry. This also and therefore applies to the teachers and teaching methods.

2.4.1 Developing Maintenance skills and expertise

It goes without saying that to an enterprise, efficient maintenance is a source of competence: it confers to the enterprise specific competitive advantages. However, for an enterprise to be able to work out maintenance schedules, plans etc and put them in place efficiently requires availability of various kinds and qualities of capability in-house and around the enterprise in question. One critical aspect of this kind of capability is human power – engineering and managerial knowledge, skills, expertise, experiences etc. In more precise terms - to build up and upgrade knowledge, skills and expertise amongst maintenance operatives, technicians,

supervisors, engineers and managers. And quite obviously the development of the above kinds of skill and expertise will call for investment, effort, time and other types of resources. The succeeding chapters in the report will examine, in some detail, the effort made by some training institutions in Tanzania to develop the kinds and levels of skill and expertise needed and relevant for efficient maintenance management and performance in the economy.

2.5 Status of Maintenance in Tanzania

A number of recent micro studies point to the poor maintenance status in many production units, service organisations and infrastructure facilities in Tanzania. In a study of the printing industry, for instance, Bundara (1992) reports that 'frequent machine stoppages due to breakdown accounted for more than 95% of the total downtime in various press rooms. Revisiting his 1992 quality and efficiency study of the Printing industry Bundara (1997:102-3) observes the following typical cases of sheer maintenance neglect.

> *(i) Over 50% of the floor area in all the 50 printing houses surveyed was pitted. All the floors in the paper store and press-rooms were very dusty. The ceilings were dirty and in some cases leaking. It is important to note that dust particles cause embossement in paper sheets. When solids are embossed, succeeding sheets contact the embossed area before that ink thereby affecting the print quality. It was observed that this problem was aggravated by the presence of uneven and pitted floors which caused jostling and rubbing effects in fresh piles of printed sheets during transportation for further processing.*

> *(ii) The major cause of machine downtime in the pressroom was due to frequent press stoppage attributed to breakdowns. It was further established that the major types of breakdown experienced by printers were: breakage of parts, wear/failure of bearings/bushes and burning of electrical parts, especially in the drive circuits.*

On this particular case Bundara (1997:102) concludes:

> ..... *the lack of maintenance was the major cause for poor quality and low efficiencies in the printing industry'.*

In a study involving about 50 local firms in processing and manufacturing sub sectors, Mjema and Kundi (1993) make observations about maintenance similar to those made by Bundara, 1992; 1997 as above.

Poor maintenance performance with poor results has also been reported in the case of road infrastructure in Tanzania. Konoike, a Japanese Construction Company, undertaking road rehabilitation works in Tanzania was reported to have lamented bitterly about the lack of proper care, use and maintenance of road infrastructure which have been rehabilitated.

The above mentioned reports also suggest that while deficiencies of skills, expertise and finances seem to have contributed to the observed poor maintenance status, but the underlying causal factor behind this prolonged situation was found to be inadequate development of a culture of maintenance amongst the workforce and the general community. On this point, Bundara, (1997:107) observes:

> .... *Nonetheless, maintenance is still low in Tanzania because of the lack of culture for it or the awareness* ..... '

Bundara, (1997:111) further observes:

> .....*It has also been shown that lack of maintenance consideration is a result of the absence of a or near absence of a culture of maintenance in the country.*

Happily, the Tanzanian situation also exhibits isolated 'islands' of exemplary maintenance performance. In an efficiency study of Air Tanzania Corporation Ltd (ATC) Tingitana (1997) observes that the Corporation has maintained excellent maintenance standards during the 1977-1996 period. On this he notes:

> *'Nineteen years later in 1996, those aeroplanes are still operating, developing 32,000 pounds of thrust, and covering great distances from Dubai all the way to Johannesburg'.*

The significant point coming from the statement made above is that for nearly two decades the aeroplanes were in place, operating standards were observed and efficiency was maintained at very high standards. Tingitana (1997) also notes that the fundamental factor behind this exemplary maintenance performance record in ATC is the development of a conducive culture of maintenance during the period considered. On this the author notes:

'We can safely say that if it was not for the sustained culture of maintenance, ATC would have been no more' ..... apart from the availability of spare parts and financial resources, the commitment by workers to maintenance played a decisive role'

Tingitana (1997:96) further notes:

'ATC management style reflected maintenance of high-technology assets. The engineers and technicians were recognised and heard. They were allowed to make critical decisions because the organisational structure allowed it. The maintenance department was made inter-pari. No back-room spanner boys. Also, the department was placed on a sound budgeting process, within the existing constraints, and the Technical Director was given a veto over quality and safety'

and that

'the system's set up ensured that what needed to be done was done. Regularly revised manuals, written regulations and procedures were obtained from the manufacturer, air worthiness authorities, the navigation act, in-house engineering groups and the management. These became the standards of measure for quality. While the maintenance department was structurally equal to other departments, internally it was designed to be stable.....'.

Yet, another example of good maintenance performance is the case of Tanzania Zambia Pipeline Limited. As Bundara (1997:105) narrates.

'The pipeline became operational in 1968 and has ever since not experienced major breakdown or need for replacement of machines on any of its 28 diesel engines. Moreover, during all this period, the engines have performed remarkably well thereby enabling the refinery at Ndola to receive more-or less the same volume of crude oil that was specified at the time of inception'.

Bundara (1997:105) explains the above observed good maintenance performance in terms of the existence in-house the company of good maintenance practices. On this the author documents:

'The above success story is a result of good maintenance practices. The company operates a scheduled preventive maintenance system on its diesel engines. In order to guarantee a sustainable system of maintenance, the management ensures that:

(a) *All workers of the company, from sweepers to the Chief executive are not only aware of, but also respect the scheduled maintenance and repairs of machinery and equipment*

(b) *Maintenance crew have the required tools and equipment for their work and are given the necessary co-operation they require by every member of the company.*

(c) *Spare parts for the replacement of components are always available when needed, 'just-in-time'. Except for the daily and weekly services, all the preventive maintenance services (based on running hours) are centralised in Dar es Salaam for the Tanzania region and in Ndola for the Zambia region. At every station, there is one mechanic to attend to minor faults. The daily and weekly services are carried out by the plant operators under the guidance of the shift leader. Throughout the author's 7 years employment with TAZAMA Pipelines there was no controversy between maintenance and operations (production) personnel regarding the authority to shut down equipment for maintenance.*

In this particular case too, as was in the case of ATC, the development of a culture of maintenance amongst the workforce seems to have been the prime factor behind the good maintenance performance record in the company.

PART TWO: FINDINGS OF THE STUDY

This part will document the main findings of the study. The part is presented in three chapters. Chapter 3, describes the training institutions surveyed in the study. Based on the description, it attempts to present a simplified characterisation of the same. An analytic account of the training curricula and programmes designed and put in place in the training institutions is given in chapter 4. And chapter 5 describes the types and levels of capabilities relevant for efficient maintenance training in the institutions surveyed. It also narrates the weaknesses within and around the institutions that hamper maintenance training.

Chapter 3

INSTITUTIONS TRAINING MAINTENANCE PERSONNEL

Introduction

This chapter will first describe the institutions training maintenance personnel in Tanzania and covered in this study (3.1). It will then characterise the institutions (3.2) in terms of training capacity within them; operational problems experienced by the institutions; linkage of the training institutions within their target group etc. And finally section 3.3 will summarise the chapter.

3.1 Description of the Maintenance Training Institutions

The Tanzanian technical qualification system can be divided into three main levels: artisan level, technician level and engineering level. Likewise, institutions training maintenance in Tanzania can be divided into these three major groups: institutions offering artisan courses, institutions offering technician certificate courses, and institutions offering degree courses. In accordance to this division, the research team surveyed all of the institutions offering degree and those offering diploma and full technician certificates. In addition, one institution offering the artisan certificates, i.e. Trade Test, was also visited.

The starting point of the survey was at the degree offering institutions, mainly the Faculty of Engineering (FoE), of the University of Dar es Salaam. All the teaching departments of FoE were visited and the corresponding staff were interviewed. The teaching departments of FoE include the department of mechanical engineering (ME), the department of civil engineering (CE), the department of electrical engineering (EE), and the department of chemical and processing engineering (CPE). The training workshop department (TWS), the Central Technical Services department (CTS), and the administration departments of FoE were not surveyed since they do not conduct any maintenance training program. The research team also visited the Bureau for Industrial Co-operation (BICO), which is a non-profit consulting wing of the FoE. BICO offers short courses in maintenance for industrial personnel. In

addition, the research team visited the department of Agricultural Engineering and Land Planning of the Sokoine University of Agriculture - SUA.

For the *"technician producing"* institutions, the research team visited the main Technical Colleges in Tanzania, i.e. Dar es Salaam Institute of Technology (DIT), Technical College Arusha (TCA), Mbeya Technical College (MTC), and Karume Technical College in Zanzibar (KTC). Likewise, the researchers visited other technical oriented research institutions, which are Tanzania Engineering and Manufacturing Development Organisation (TEMDO), Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC), and Tanzania Industrial Research and Development Organisation (TIRDO). The research team also visited Dar es Salaam Regional Vocational Training and Service Centre (DRVTSC) as a representative of vocational training centres in Tanzania. The paragraphs that follow describe the institutions surveyed; and table 3.1 summarises this information.

(i) Dar es Salaam Regional Vocational Training and Service Centre (DRVTSC)

DRVTSC is one of eight designated Regional Vocational Training and Service Centres (RVTSC), directly under Vocational Education Training Authority (VETA), an autonomous government agency established by Act of Parliament No. 1 1994. The major trade areas offered by DRVTSC are civil, mechanical, electrical and commercial based trades. The centre was originally found in 1969 as the National Vocational Training Centre (NVTC), which offered occupational courses in motor vehicle, mechanics, fitting & turning, and carpentry & joinery. Currently the centre offers 15 different occupational trades and is the largest of all vocational training centres in the country directly under VETA with the capacity of about 700 trainees.

Like all other RVTSC which are directly under VETA, the source of funding is mainly from donor assistance. Even the introduction of maintenance in this institution was mainly due to donor-led efforts. A Danish agency for international development DANIDA introduced the course on maintenance in 1993 in Dodoma as a pilot project. Later on maintenance was put as a special course in all trades as from 1994. Once per year a seminar on maintenance is run for all instructors at DRVTSC to enhance and upgrade their awareness and understanding of maintenance.

(ii) Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC)

CAMARTEC is a research institution and was established by an Act of Parliament in November 1981. The centre started officially in July 1982 from a merger of two separate institutions: Tanzania Machinery Testing Unit (TAMTU), and Arusha Appropriate Technology Project (AATP). TAMTU activities dated a far back as 1955 and used to test agricultural machinery for their suitability to Tanzanian conditions. AATP was established in 1977 as a project under Small Industries Development Organisation (SIDO). The function of the project was to do research and development work in building materials, rural transportation, energy and water supply.

The centre is a parastatal organisation under the Ministry of Industries and its primary mission is to improve the quality of rural life through development, adaptation and implementation of appropriate technologies in the fields of agricultural mechanisation, water supply, building construction and sanitation, rural transport and energy. In the past the centre ran short courses on maintenance on rural transport for four weeks, which was funded by UNIDO. This course was however stopped due to lack of funds.

The interviewees were of the opinion that maintenance has a cultural dimension. They mentioned some of the cultural elements related to maintenance as lack of appreciation of technology and lack of maintenance skills.

Table 3.1: Institutions training maintenance in Tanzania.

Name of Institution	Address	Telephone	Fax	Ownership	Contact Person	Title of the contact person
DRVTSC	Box 40274 Dar es Salaam	051 862652 or 862583		Government department	Mr. A.J. Lubasha	Training Manager
CAMARTEC	Box 764 Arusha	057-3222 or 8250	057-8250	Parastatal	1. Mr. W.M. Baitan 2. Mr. H.Z. Ngowi	1. Director Agro technology directorate 2. Head biogas unit dept.
TEMDO	Box 6111 Arusha	057-8058 or 6220	057-8318	Parastatal	Mr. G. Msolla	Director General
KTC	Box 467 Zanzibar	054-30222		Government department	Dr. I. M. Hija	Principal
MTC	Box 131 Mbeya	065-3016 or 3017		Government department	Mr. Y. U. Mgana	Head of Dept. of Mechanical
TCA	Box 296 Arusha	057-2648 or 3040	057-8337	Government department	Mr. T.P.N. Manyaga	Vice Principal
DIT	Box 2958 Dar es Salaam	051-152032		Government department	1. Mr. B.N.D. Shija 2. Mr. J. Aligawesa	1. Ag. Principal 2. Co-ordinator culture of maintenance
SUA	Box 3003 Morogoro	056-4216	056-4388	Government department	Dr. N. I. Kihupi	Head of dept. of Agriculture Engineering
ME-FoE	Box 35131 Dar es Salaam	051- 410754	051- 410029	Parastatal	Dr. C.W.M. Nyahumwa	Ag. head of department
CE-FoE	Box 35131 Dar es Salaam	051- 410756	051-410029	Parastatal	1. Dr. N.M. Lema 2. Prof. T. Rwebangira 3. Prof. F. Mtalo 4. Dr. L. Shirima 5. Dr. A. Mrema	1. Construction Management 2. Transportation Engineering 3. Water Resource Engineering 4. Structural Engineering 5. Building Materials
EE-FoE	Box 35131 Dar es Salaam	051-410762	051- 410029 or 410380	Parastatal	Dr. N. Mvungi	Head of Department
CPE-FoE	Box 35131 Dar es Salaam	051- 410***	051- 410029	Parastatal	Dr. E. Masanja	Head of Department
BICO-FoE	Box 35131 Dar es Salaam			Parastatal	Dr. B. Nyichomba	Director

(iii) Tanzania Engineering and Manufacturing Development Organisation - TEMDO

TEMDO is a research institution for applied R&D. The mission of TEMDO is to enhance the productivity and competitiveness of the Small and Medium Size Enterprises (SMEs) through the supply and promotion of engineering design and manufacturing services. Likewise, TEMDO provide practical training for engineers, technicians and artisans to raise their practical skills in design, production and maintenance of industrial machinery equipment.

Maintenance is one of the important missions of TEMDO since the institute offers maintenance support services, spare parts design and manufacturing, and also direct maintenance support and training of maintenance personnel.

TEMDO staff interviewed felt that maintenance has a cultural dimension. They mentioned the cultural elements related to maintenance as poverty and lack of awareness among the top management. The funding of maintenance training at TEMDO are mainly raised from fees paid by participants and donor supports, especially the by CDG.

(iv) Karume Technical College (KTC)

The mission of KTC is to teach Full Technician Certificate in the fields of mechanical, electrical, civil and automotive engineering. KTC consists of five main departments: mechanical, automobile, telecommunication and electronics, electrical and civil engineering departments. Maintenance does not feature as a significant component of college's activity programme. Further, the training in the college differs from department to department. For example, in the departments of electrical, automobile and mechanical engineering maintenance is a significant course, whereas in civil engineering maintenance is just a small portion of other courses. Maintenance training is not conducted at all in Telecommunications department.

The staff of KTC, however, observed that maintenance has cultural dimension. They mentioned two cultural elements, which are related to maintenance as the lack of maintenance mindedness and lack of economical considerations, which is attributed to poverty.

(v) Mbeya Technical College (MTC)

MTC offers courses leading to Full Technician Certificates in the fields of architecture, mechanical, electrical and civil engineering. The execution of maintenance is one of the main objectives of MTC since the graduates of MTC are expected to be engaged in the installation, operation, maintenance, servicing and repair of engineering machinery and equipment in their related fields of work.

Staff interviewed at the college accepted that maintenance has cultural dimension. They mentioned six cultural elements related to maintenance as: a) lack of awareness for need of maintenance even at personal level, b) absence of personal initiatives with regard to maintenance, c) limited promotion of maintenance ideas in the media, d) inadequate systems for maintenance, e) poor co-ordination between production and maintenance, and f) lack of maintenance mindedness on the part of management.

The funding for the maintenance training programmes is mainly from government sponsorship for FTC students and course fees from short courses participants. Currently there is no external funding for courses offered by MTC.

(vi) Technical College Arusha (TCA)

TCA became operational in 1978. It offers courses leading to Full Technician Certificates in the fields of automotive, civil, electrical, highway and mechanical engineering. In the last twenty years TCA trained a total of 2191 technicians, out of which 323 were women. The teaching of maintenance is one of the major objectives of the college.

The teaching staff of TCA also felt that maintenance has a cultural dimension. They mentioned four cultural elements related to maintenance: a) negligence attitudes developed due to prevailing economic problems, b) no budget for maintenance, c) job description does not emphasise the importance of maintenance, and e) awareness for preventive maintenance is lacking.

The source of funding of maintenance programmes at TCA is mainly government funding for FTC students and course fees from participants of short courses. There was also Integrated Roads Programme (IRP), which used to fund the short course, but the project has now ended.

(vii) Dar es Salaam Institute of Technology (DIT)

The mission of DIT is to train technician to the level of Full Technician Certificate and to offer courses leading to Diploma in Engineering. The objective of the institute is to become a centre of excellence in the field of applied science, technology and enterpreneurship in Tanzania. The institute conducts research and teaches the latest technology relevant to Tanzania and strives to be recognised by community, commerce and industry.

The execution of maintenance is one of the major objectives of DIT, since the products of DIT will be engaged in the maintenance work after completion of their courses at DIT. There is a maintenance department to take care of the properties of the institute, also each department takes care of its own facilities. Maintenance concepts are included in each discipline and in almost each subject. However, there is not maintenance as a separate course, except in civil engineering where there is a course on maintenance of roads.

(viii) Sokoine University of Agriculture (SUA)

The Sokoine University of Agriculture was established in 1984. Prior to that, it existed as a Faculty of Agriculture within the University of Dar es Salaam. SUA has three faculties: Faculty of Agriculture; Faculty of Forestry; and Faculty of Veterinary Medicine. The Faculty of Agriculture is the largest and has seven departments. One of the seven departments is that of Agricultural Engineering and Land Planning, which offers a four year course leading to the degree of Agricultural Engineering. This course is administered in collaboration with the Faculty of Engineering (FoE), of the UDSM. The Agriculture Engineering students spend their first two years of study at the UDSM and the remaining two years at SUA.

The mission of the SUA and in particular the department of Agricultural Engineering is to teach students to B.Sc. and M.Sc. level in Agriculture Engineering. Although maintenance is perceived as an immense problem, especially in agricultural equipment and agricultural systems, there is not a maintenance subject in the curriculum of Agriculture Engineering.

The interviewee agreed that maintenance has a cultural dimension, and mentioned two cultural elements related to maintenance: attitude of the people towards maintenance and slackness. The SUA does not have even short courses in maintenance but there is a plan to establish short courses on maintenance using a repair workshop for scientific equipment, which is a project funded by NORAD.

(ix) Faculty of Engineering (FoE), of the University of Dar es Salaam.

The University of Dar es Salaam is the largest University in Tanzania in terms of number of students, number of academic staff and physical facilities. The Faculty of Engineering was established in 1973 and consists of four teaching departments, two administrative departments, a training workshop department and a department responsible for managing externally funded finances. The Faculty has strong relations with industries through the Office for Relation with Industry (ORI) and Bureau for Industrial Co-operation (BICO). However, at department level the relationship with industries is not very active.

Since its inception the Faculty has been able to train 2421 engineers in the fields of Civil Engineering (CE), Mechanical Engineering (ME), Electrical Engineering (EE), and Chemical & Process Engineering (CPE).

In the curriculum of the Faculty there is a full fledged course in maintenance management, which is compulsory course for students in the ME, EE and CPE departments. In the department of CE maintenance is taught as a unit in a number of courses. Apart from civil engineering department, maintenance is one of the major objectives of the institution. The source of funding for maintenance training at FoE is mainly from the government sponsorship of students. Likewise, the Faculty runs short courses in maintenance, whose funding is the fees from the course participants.

(x) Bureau for Industrial Co-operation (BICO)

BICO was established in 1990 and is a non-profit making consultancy wing of the FoE with the main objective of co-ordinating the Faculty expertise to contribute effectively to the industrial development of Tanzania. The consultants of BICO are the more than 100

academic staff who are highly qualified, both professionally and academically. The majority of them hold Ph.D. degrees. For multi-disciplinary consultancy assignment, BICO has a unique opportunity to liase with University Consultancy Bureau (UCB) and form the most competent team(s) composed of members from more than two dozen specialised disciplines available in the University.

The main objective of BICO is therefore to enable the capability of the Faculty of Engineering to contribute effectively to the industrial development of the country through research and development activities, consultancy and expert professional service. BICO runs a number of Professional Development Programmes (PDPs) and maintenance is one of them. The source of funding for these courses is mainly the fees from the participants.

3.2 Characterisation of the Maintenance Training Institutions

3.2.1 Training Capacity, Orientation and Staffing Strength

The research team visited both teaching and non-teaching institutions, which in one way or another train maintenance. In terms of number of students and number of staff, the teaching institutions have larger training capacity than non-teaching institution. FoE has the largest students and staff capacity followed by DRVTSC. Currently the total number of students at FoE is 1000 whereas at DRVTSC is 700. The majority of maintenance trainers at FoE are Ph.D. holders. The characteristic of each visited institution is depicted on Table 3.2.

As it can be seen from table 3.2, apart from DRVTSC, non-teaching institutions offer practical oriented maintenance programmes whereas teaching institutions' training of maintenance is more theoretical oriented. However, for short courses teaching institutions also offer more practical oriented courses due to the target groups. It can also be noted that, non-teaching institutions offer only short term courses in maintenance whereas teaching institutions offer both short and long term courses.

Regarding to the staffing strength technical colleges and DIT have staff with many years of practical experience, whereas Universities have highly academically qualified staff but with less practical experience. Among the technical colleges, MTC have high proportion of academic staff with Masters degree, whereas at DIT some instructors are FTC holder, but the

majority of the academic staff have Diploma. DRVTSC has one degree holder instructor whereas the rest of its academic staff are Trade Test I (TT I) holders.

3.2.2 Operational Problems and Bottlenecks

Table 3.3 shows the main problems facing each of the training institution. It is vivid from the table, that financing was reported as a major constraint in almost all of the visited institutions. This financing problem is not only for the training of maintenance, but faces almost every corner in training institution.

Table 3.2: Characteristic of maintenance training institutions with respect to maintenance.

Institution	Program duration	target group	training capacity	qualification of students	theoretical or practical	number of Staff	qualification of staff	experience of staff	number of graduates
DRVTSC	long	students	400	STD VII	40% theory	90	TTI	10+ years	400
	short	instructors	90	TT I	100% theory				90
TIRDO									
CAMARTEC	short	artisan and owner of equipment	15	TT	60% practical	3	BSc(Eng.)	15+ years	
TEMDO	short	engineers and technicians	20	FTC, BSc	80% practical	5	BSc(Eng.)	10+ years	131
KTC	long	students	20	form IV	80% theory	15	B.Sc. and Diploma	10+ years	
	short	technicians	12	FTC	40% theory	15	B.Sc. and Diploma	10+ years	
MTC	long	students	25	form IV	80% theory	14	MSc and DTE	12+ years	
	short	technician and artisan	10	FTC, TT	100% theory	14	M.Sc. and DTE	12+ years	83
TCA	long	students	99	form IV	50% theory	5	B.Sc. and Diploma	20+ years	689
	short	technician and artisan	20	FTC, TT	60% theory	5	B.Sc. and Diploma	20+ years	
Telecoms-DIT	long	students	20	form IV	40% theory	8	DTE		125
Mechan.-DIT	long	students	70	form IV	40% theory	15	Diploma	7+ years	250
Electrical-DIT	long	students	60	form IV	90% theory	9	Diploma	20+ years	
	short	craftsmen	60	TT	90% theory	9	Diploma	20+ years	23
Civil - DIT	long	students		form IV		9	FTC and Diploma		
SUA	long	students	20	form VI	90% theory	9	Ph.D.	little	15
ME-FoE	long	students	40	form VI	100% theory	3	PH.D.	little	169
CE-FoE	long	students	70	form VI	100% theory	6	PH.D.	little	338
EE-FoE	long	students	40	form VI	100% theory	3	PH.D.	little	141
CPE-FoE	long	students	40	form VI	100% theory	4	PH.D.	little	106
BICO-FoE	short	engineers, technicians	40	B.Sc., FTC	70% theory		PH.D.	little	

Table 3.3: Main Problems facing each of the training institutions

Institution	finance	staff number	Physical facilities	Administration	staff remuneration	staff motivation	industry link	qualification inputs	curricular development	information resource	experience of trainers
DRVTSC	1	0	0	0	1	1	0	1	0	1	0
TIRDO											
CAMARTEC	1	0	0	0	0	0	0	0	0	0	0
TEMDO	0	0	1	0	0	0	1	0	0	0	1
KTC	1	1	1	0	0	0	0	0	1	1	0
MTC	1	1	1	0	1	1	1	0	1	1	1
TCA	1	1	0	0	1	1	0	1	1	1	0
Telecoms-DIT	1	0	0	0	1	1	0	0	1	1	0
Mechan.-DIT	1	1	1	1	1	1	0	0	1	1	1
Electrical-DIT	0	0	1	0	0	0	1	0	0	1	0
Civil - DIT	1	0	1	0	1	1	0	0	1	1	0
SUA	1	0	1	0	0	0	0	0	1	0	1
ME-FoE	1	0	1	0	1	1	1	0	0	1	1
CE-FoE	1	1	1	0	1	1	1	0	1	1	1
EE-FoE	1	1	0	0	0	0	0	0	0	0	0
CPE-FoE	0	0	0	1	1	0	0	0	0	0	0
BICO-FoE	0	1	0	1	0	0	1	0	0	0	0

Key:

1 The problem was mentioned to exist

0 The problem was not mentioned

The second include information resources such as books, journals, etc. Other mostly mentioned problems include physical facilities, and staff remuneration. Most of the maintenance training institutions did not have maintenance laboratories and some do not have even models for training of maintenance. Staff remuneration is a problem, which is felt by almost all of the teaching institutions. It is striking to mention that, all non-teaching institutions did not mention the problem of staff remuneration and staff motivation, whereas almost every teaching institution indicated that they have problems with regard to staff remuneration and staff motivation.

Curriculum development is another problem, which is felt by mostly the technical colleges. Almost all of the technical colleges lamented over the problem of curriculum development, and they lamented that they do not have the mandate to change the curriculum. The curriculum for technical colleges is provided directly from the ministry; and that the technical colleges cannot change it to fit the current demand from the industries. However, other sources indicate that, the technical colleges are supposed to initiate the required changes and the ministry has just to endorse the changes in the curriculum.

Further more, apart from TCA and DRVTSC, the rest of the institutions did not have problems with entry qualifications of their target groups. It is amazing that this problem was not mentioned by high learning institutions, the Universities of Dar es Salaam and Sokoine University of Agriculture. This problem is so vivid that the University of Dar es Salaam had proposed for an entry examination for the applicants. The next least mentioned problem is the general administration of the institutions, this situation could have been attributed to the fact that the interviewee were mostly head of the departments of the concerned institutions. Figure 3.1 depicts the problems with respect to the number of responses.

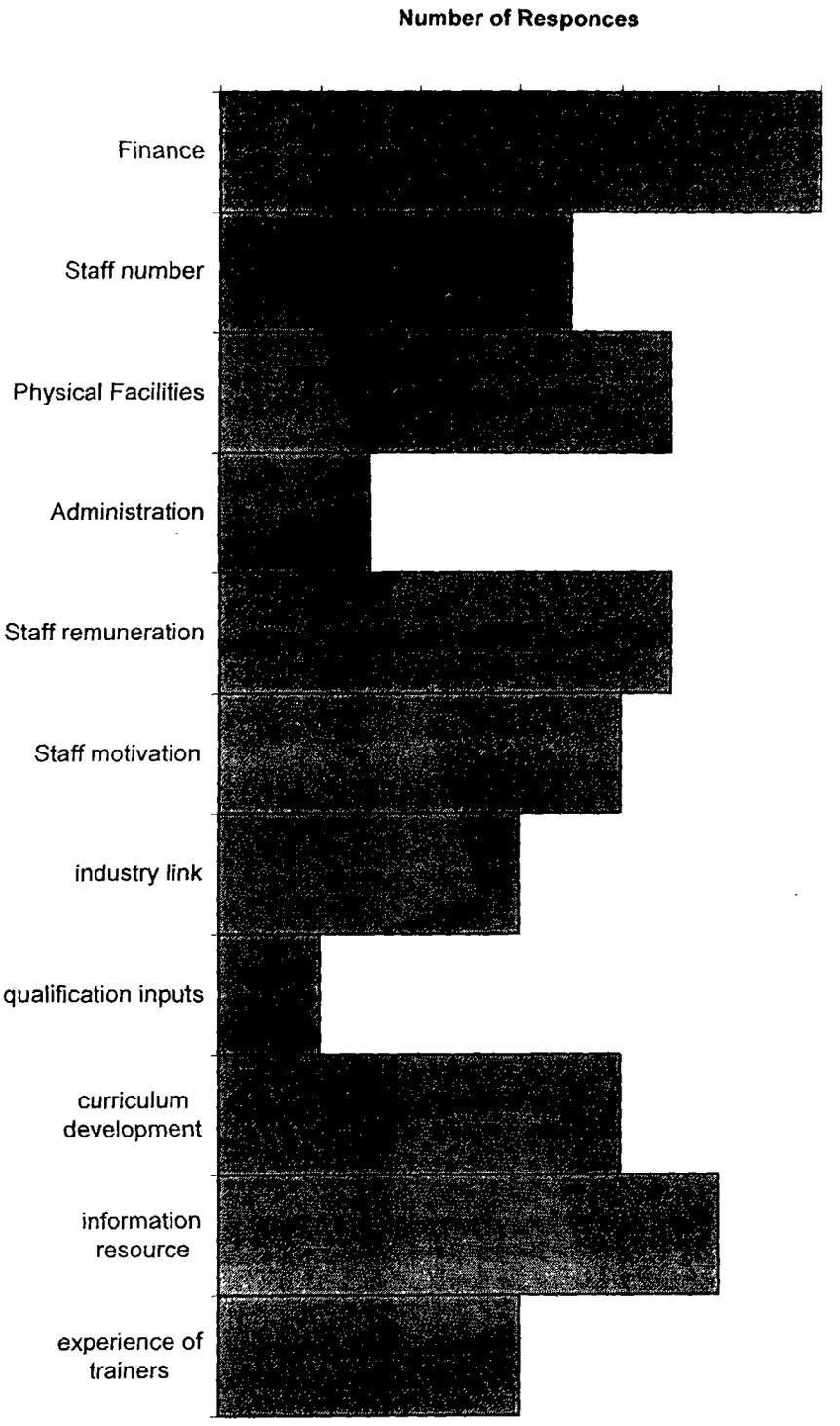

Figure 3.1 Problems facing maintenance training institutions

3.2.3 Networking with other training institutions.

As it can be seen from table 3.4 most of the maintenance training institution do not have collaboration links with other institutions. However, TCA mentioned that, it has collaboration with other technical colleges: DIT and MTC. On the other side MTC showed that they do not have any kind of collaboration. It is possible to assume that this collaboration question was not clearly understood by the other concerned side. For example TCA mentioned that, they had at least once exchanged staff with MTC, whereas MTC did not mention this kind of staff exchange.

Collaboration of institutions could be beneficial to the institutions through staff exchange, equipment exchange or even improvement of teaching materials and curriculum reviews. Taking into consideration the prevailing economic hardships, collaboration of the institutions could facilitate efficient use the existing meagre resources for the benefits of all institutions. TCA has even links with a foreign technical institution - KSR from Germany. This link is funded by a German government agency for technical co-operation - GTZ. Under the link programme staff exchange between KSR and TCA has been effected. This link can help TCA to acquire various facilities needed for teaching. Likewise, CAMARTEC indicated that they have links with local institutions such as Community Development Training Institute - CDTI, Livestock Training Institute - LITI, TEMDO, and Valmet/Sisu company, which collaborates in tractor maintenance training. The collaboration between CAMARTEC and these institutions are in the areas of food processing and animal keeping (with CDTI), solar energy (with TEMDO), and also in staff exchange.

Table 3.4: Existing collaboration between training institution

Institution	collaborating institution	areas of collaboration
DRVTSC	Linkage with other RVTSC	Collaboration in maintenance training
TIRDO		
CAMARTEC	CDTI (Community Development Training Institute), Valmet/Sisu, LITI (Livestock Training Institute) TEMDO	Collaboration in food processing and animal keeping Collaboration in Solar energy Collaboration in staff exchange
TEMDO	CDG	Funding and joint activities under the project, which ended in 1994
KTC	None	N/A
MTC	None	
TCA	DIT, MTC & RVTSC (Moshi), KSR (Germany)	Exchange course programs, Facility loan/exchange, Staff exchange (once with MTC) Students visits (especially with RVTSC) Staff visit (KSR) - funded by GTZ
DIT	Link with Industries	Industrial people used to come and teach on part time basis
SUA	No link	
ME-FoE	Very little links with industry	
CE-FoE		
EE-FoE		
CPE-FoE	Industrial link through its graduates	
BICO-FoE		

People from Industry used to be hired by DIT to teach on part time basis, so as to strengthen the practical orientation of courses offered by DIT. This program created very good collaboration between DIT and the industry. On one side DIT benefited from the experience of trainers from the industry, and the people from industry benefited from new ideas at DIT. This program has been discontinued due to financial constraints at DIT.

3.2.4 Linking with Target Groups and Sustainability of Training Institutions

The information pertaining to the linking with the target group, sustainability of training institutions and training costs are depicted on table 3.5. Most of the maintenance training institution reach out their target groups through advertisements in newspapers. Some of them

take an extra effort to visit or direct mailing the potential participants of the courses they are offering. TEMDO is an example institution, which make industrial visits or make technology audit to know the need of the potential customer for its courses in maintenance. CAMARTEC also uses the training of the users of the CAMARTEC-developed technologies as a way for promoting maintenance. For some of the departments of the university institutions there is very little effort done to reach out to the target groups. They use mainly advertisements in the newspapers as their strategy for reaching the potential customers. However for departments, which make direct contacts with the customers, such as direct mailing, the short courses in maintenance offered received a good number of participants.

Regarding the assessment of the needs of the market, it is only TCA, which carry out surveys to determine the needs of its programmes in the market. KTC uses information from its Alumni to determine the needs of the market. Likewise, KTC conducts field survey to observe the needs of the customers through discussions with the potential customers.

With regard to sustainability of the maintenance training programmes, most of the interviewed institutions showed that these programmes are sustainable. However, TEMDO commented that the programmes are sustainable only if they are tailor made. TCA and DIT indicated that the programmes are only partly sustainable due to the problem of funding. Most of the technical colleges indicated that they face problems of having good numbers of participants for their advertised programmes. A good example for this poor attendance of participants is the one experienced by MTC. MTC prepares a good number of short courses in maintenance to cover a whole year, but some of the programmes had to be cancelled due to very few responses from the customers.

The training costs for short course in maintenance ranged from Tshs. 50,000/- to 150,000/- for a program covering a whole week. TEMDO and KTC have the lowest training fees for short courses whereas the FoE has the highest fees. For the case of KTC the fees are low due to the fixation of the upper limit fees for short courses training by the relevant ministry in Zanzibar. For full time training programmes, it is only the technical colleges, which were in position to give this kind of data. The cost of training technicians per year ranged from Tshs. 750,000/- for off-campus students to Tshs. 1,700,000/- for resident students. In comparing the technical colleges, it can be deduced that DIT has higher costs for resident students than TCA, whereas TCA has higher costs for non-resident students than DIT.

Table 3.5: Linking with the target group, sustainability of Training Institution

Institution	Strategy for reaching target group	Promotional mechanisms	Market needs Assessment	Average cost of Training	Fees	Financial sustainability
DRVTSC	N/A					
TIRDO						
CAMARTEC	advertisement	through training users of the developed technologies				
TEMDO	industrial visits, technology audits	advertising		50,000/- per week		Only if it is tailor made
KTC	Advertisement		discussion visit, field info from Alumni.	50-80,000/-		yes
MTC	Advertisement	direct involvement of students in maintenance, industrial visits, motivation of participants, follow-up programmes		85-105,000/-		yes
TCA	Advertisement	Industrial visits	survey, physical visits	1,500,000/- full time 800,000/- part time	120,000/-	Partly sustainable
DIT	Advertisement and direct visits			1,700,000/- full time, 750,000/- off campus 1.5*FTC for Diploma	70-90,000/- for short courses	Partly sustainable
SUA	N/A					
ME-FoE	little effort is done to reach out the target group.	very little is done to promote maintenance in industry				
CE-FoE	advertisement of PDPs	information showing needs		150,000/- for short courses		yes
EE-FoE	direct mailing	database for participants and write directly to potential customers.		80-120,000/- on short courses		they are sustainable
CPE-FoE	sending invitations	showing people what is wrong, and advice them to attend short courses				
BICO-FoE	advertising on newspaper, physical visits	selling a package				

Table 3.6 Maintenance Training-Related Plans

Institution	Main Future (Maintenance Related) Plans
DRVTSC	Modular basis training including PM
TIRDO	
CAMARTEC	Maintenance of intermediate agriculture machinery, maintenance of oil processing machinery, maintenance of biogas
TEMDO	Survey to understand training needs, to formulate tailor made training programmes, to formulate proposal, which are attractive for sponsorship from donor agencies
KTC	Maintenance Training for Drivers, No specific plans
MTC	Improvement of PM Training with emphasis on Database management, model workshop for maintenance training, integrating bldg maintenance in Architecture, conservation of building structures
TCA	To add one department offering a course of maintenance of electronic equipment, one department to offer an advanced course
DIT	establish a repair centre, strengthening links with industry
SUA	Repair workshop for scientific equipment
ME-FoE	Review of maintenance course offered
CE-FoE	Refine program and make it more relevant, Emphasis on maintenance management than maintenance technics, to make maintenance a full fledged course, improve teaching facilities, creating information base for maintenance, to start a graduate course on maintenance.
EE-FoE	Maintenance for scientific equipment in the sub-region
CPE-FoE	curriculum review in plant design to include piping maintenance, aspects of maintenance to be addressed from the first year
BICO-FoE	No specific plans

3.2.5 Maintenance Training-Related Plans

Each of the institution surveyed has designed specific plans for the improvement of maintenance training in their institution. However, BICO-FoE and KTC did not have specific plans during the time they were visited. The maintenance plans for each visited institution are depicted on table 3.6. DRVTSC plans to conduct on modular basis the training of maintenance and to include the preventive maintenance as part of the curriculum.

CAMARTEC on the other hand plans to prepare courses on the maintenance of intermediate agricultural machinery, maintenance of oil processing machinery and maintenance of biogas plants.

The future plans of TEMDO include to conduct surveys to establish the need for maintenance training and to formulate tailor made programmes. Likewise, one of the main problems affecting the sustainability of maintenance courses offered by TEMDO is lack of sponsorship. Therefore the second immediate plan of TEMDO is to formulate proposals for maintenance training, which will attract funding from potential sponsors.

MTC plans to make improvements in the training of preventive maintenance, with emphasis on inventory control and introduction to database management systems. Likewise, MTC is planning to acquire models for training of maintenance in the form of miniature plants. In the department of Architecture of MTC the plan is to integrate the maintenance of buildings as part of architecture courses. Likewise, a course will be offered by the Architecture department aimed at imparting knowledge to the students on the conservation of building and structures. TCA plans to add one department offering a course of maintenance of electronic equipment and another department to offer advanced courses in maintenance. DIT plans to establish a repair centre for all the institute equipment and infrastructure and also to strengthen its links with industries.

SUA is in the process of establishing a repair workshop for scientific equipment - a project funded by NORAD. This centre will be a nucleus of maintenance training, which will be offered by SUA in the near future. For the time being SUA does not have any course in

maintenance, and there exists no plans for integrating maintenance course in the SUA-offered course of agriculture engineering.

The department of mechanical engineering of FoE plans to review its maintenance course and to tailor it to the current market needs. Similarly the department of civil engineering is in the process of reviewing its curriculum and creation of a full fledged course of maintenance. The full fledged course will also include a graduate level course in maintenance management. Likewise, the department would like to make the course more relevant to the engineering students. The plan is to put emphasis on the teaching of maintenance management and focus less on the training of maintenance technics. In addition the civil engineering department would like to improve its teaching facilities and to create an information base for maintenance related data.

The department of electrical engineering plans to introduce a course for maintenance of scientific equipment for the sub-region. The chemical and processing engineering department plans to review the course of plant design to include piping maintenance. Likewise, the department plans to introduce the concepts of maintenance right from the first year of its degree programme.

3.3 Summary

In this survey 10 institutions offering maintenance courses in Tanzania were visited. The institutions have adequate personnel capacity to train maintenance personnel of all categories for the Tanzanian industries and infrastructure. The capacity in this sense will refer to a good number of qualified staff, laboratories and workshops, miniature plants, teaching models and classrooms. However, the existing capacity is not fully utilised due to various factors. The main factor as perceived by the institution is lack of financing of the maintenance programmes such that the institution cannot make appropriate promotion of maintenance. Likewise, public awareness is another factor contributing to under utilisation of the maintenance capacities existing in the training institutions. The institutions advertise maintenance courses in newspapers but the turn out is very poor. However, for institutions, which make direct contact with customers the number of participants in their maintenance programmes is encouraging.

Most of the respondents, indicated that maintenance has cultural dimensions. Various reasons such as lack of awareness regarding maintenance, lack of budgeting for maintenance, negligence, etc., confirm this assertion that maintenance has culture dimensions.

It was also indicated that the training of maintenance is sustainable in the institutions surveyed. However, one institution indicated that the training is sustainable only if the training is tailor made to fulfil a specific need. Likewise, each visited institution indicated specific future plans to improve the training of the maintenance subject in their respective institution.

Chapter 4

Maintenance Training Curricula and Programmes

4.0 Maintenance Curricula and Programmes offered

Maintenance programmes are offered as components of long courses for Full Technician Certificate, Diploma and Bachelor of Science degrees. In these long courses (at various colleges, Institutes and Universities), maintenance programmes feature as course topics with relevance to maintenance training. Some topics like 'Maintenance of Roads' in Highway FTC course are very explicit in their relevance to maintenance training; while other topics like Engineering design are not so explicit. However, the coverage of maintenance relevant topics in various long courses varies from very high coverage to very low. In the department of Civil Engineering of the Faculty of Engineering at the University of Dar es salaam, for example, maintenance as a course subject has only been introduced three years ago in the 25 years of existence of the Faculty. Table 4.1 summarises the long courses offered by various Technical Institutions with relevance to maintenance training.

Besides long courses, almost all training institutions surveyed offer short courses with relevance to maintenance lasting between 1 week to 3 months. Most of the short courses are conceived by staff members and offered to the general public as well as to various organisations and institutions. There seems to have been only limited *needs assessment* by various institutions when mounting these courses. Generally, respondents were not very firm to the question of how they determined the market needs for the maintenance courses they offered. Partly because of lack of a needs assessment, these short courses have not been very successful. The courses have often attracted very small numbers of participants and in some cases no participants at all. Table 4.2 summarises short courses offered by various training institutions.

Table 4.1 **Maintenance curricula and programmes**

Sr. No.	Institution	Name of course	Duration (yrs)	Relevant maintenance topic(s)
	Faculty of Engineering. UDSM			
	Dept. of Civil Engineering	B.Sc. (Civil)	4	▪ Construction Management
	Dept. of Mechanical Eng.	B.Sc. (Mech. Eng.)	4	▪ Industrial Safety and Maintenance ▪ Operations research
	Dept. of Electrical Eng.	B.Sc. (Electrical)	4	▪ Safety and maintenance
	Dept. of Chemical and Process Eng.[9]	B.Sc. (Chem. &Process)	4	▪ Industrial Safety and Maintenance ▪ Operations research
	Sokoine University of Agriculture			
	Dept. of Agricultural Eng. and Land Planning	B.Sc. (Agric.)	4	▪ Not Available
	Technical Colleges			
	Dar es salaam Institute of Technology	FTC ADE	3 3	▪ Road maintenance ▪ Building construction ▪ Automotive maintenance and repair
	Mbeya Technical College	FTC	3	▪ Electrical equipment installation and maintenance ▪ Manufacturing engineering
	Technical College Arusha	FTC	3	▪ Production Technology ▪ Road Maintenance ▪ Construction Management
	Karume Technical College	FTC	3	▪ Road Maintenance ▪ Automotive maintenance and repair ▪ Electrical power utilisation ▪ Production technology
	Rwegarulila Water Resources Institute	FTC	3	▪ Maintenance of Drilling Rig ▪ Water resources management ▪ Water quality management ▪ Construction management ▪ Operations and Maintenance of water supply systems

Table 4.2 Short courses in Maintenance

Institution	Short course(s)	Duration	Target group	Remarks
EE/FoE	▪ Maintenance of Electronic equipment	2 wks	Engineers Technicians	Course discontinued because of manpower constraints
CE/FoE	▪ Nil			
ME/FoE	▪ Nil			
Dar es salaam Institute of Technology	▪ Practical electronics ▪ Digital electronics ▪ TV and Video repair ▪ Microprocessor technology ▪ Computer repair ▪ Radio repair ▪ Scientific instrumentation repair and maintenance	6h/wk x 4 wks 6h/wk x 4 wks 6h/wk x 4 wks 6h/wk x 4 wks 6h/wk x 4 wks 6h/wk x 4 wks 8h/wk x 4wks	Form IV Form IV Form IV Form IV Form IV Form IV Industry employees	
Mbeya Technical College	▪ Repair Technology	Not Available	Forms IV, VI, Grad.	The college has been fairly successful in conducting short courses.
	▪ Maintenance Management		Forms IV, VI, Grad.	
	▪ Preventive Maintenance		Forms IV, VI, Grad.	
	▪ Motor vehicle maintenance and repair		Forms IV, VI, Grad	
	▪ Motor vehicle Fault Tracing and Testing	Not Available	Std VII, Forms IV+VI	
	▪ Electrical Fault tracing and Trouble shooting of Industrial/Domestic Appliances	Not Available	Std VII, Forms IV+VI	
Technical College Arusha	▪ Repair welding ▪ Road Maintenance ▪ Foundry ▪ Hydraulics and Pneumatics			
Karume Technical College	▪ Computer Maintenance	1 wk	Technicians/Alumni	
	▪ Automotive electrical systems	3h/day x 3 mons	Artisans	
TEMDO	▪ Production and Maintenance supervisory	40h/wk x 2 wks	Supervisors Managers	100% theory
	▪ Production and Maintenance Management	2 wks	Engineers Technicians	100% theory. Fair interest at supervisory level
	▪ Spare parts design and manufacture			75% theory. Low response from the market

[9] Maintenance teaching at CPE and EE is covered by the Department of Mechanical Engineering

Institution	Short course(s)	Duration	Target group	Remarks
Rwegarulila Water Resources Institute	▪ Rainwater harvesting technologies (choice, design, construction, operation and maintenance)	Not available	Technicians Form IV Artisans	College has not been so successful in attracting participants for the short courses
	▪ Management of operation and maintenance in Rural drinking water supply and sanitation			
	▪ Preventive maintenance of pumps			
	▪ Servicing and maintenance of water pumps			
	▪ Protection of water sources			
	▪ Choice, installation, operation and maintenance of manually operated pumping/lifting devices			
	▪ Welding and maintenance of water storage steel tanks			
	▪ Methods of conserving or augmenting water supplies			
	▪ Drainage and sewerage			
CAMARTEC	Engine conversion	4 wks	Engineers Technicians	GTZ funded, no fees
	▪ Tractor operation	3 mons	Owners and operators	Funded by VALMET and Sida
	▪ Vegetable oil Press (manufacture and use)	4 wks	Artisans Technicians	Fee paying course
	▪ Biogas technology	4 wks	Technicians	Fee paying / international
	▪ Rainwater harvesting	4 wks	Technicians	DANIDA funded
	▪ Manufacture of Cinva rams and pumps	4 wks	Technicians	DANIDA funded
	▪ Rural transport facilities	4 wks	Artisans Technicians	Fully supported by UNIDO

4.1 Coverage of relevant maintenance topics

The levels of coverage of relevant maintenance topics in various training institutions vary. Different institutions place emphasis on different topics. There are no specific reasons for these variations. Table 4.3 summarises information on level of coverage of various maintenance topics in long courses offered by training Institutions surveyed.

4.2 *Trainers of Maintenance Curricula and Programmes*

The spectrum of maintenance trainers is wide. Trainers range from Artisans holding Trade Test Grade I, Technicians with FTC to engineers with BSc, MSc and PhD degrees. The lower cadres tend to train in artisan and technician programmes, while graduates and Ph.D. holders cover degree courses. No local institution is doing postgraduate training in maintenance.

Vocational training institutions tend to be dominated by trainers who are Artisans (mainly Trade Test Grade I) while Technical Colleges/Institutes of Technology employ technician and engineer trainers with FTC and BSc respectively. At University level, trainers are engineers with MSc and PhD degrees. Table 4.6 summarises the results of the survey on trainers of maintenance at various local institutions.

Generally trainers of maintenance hold respectable academic qualifications. Respondents to this survey have also put the experience of their trainers quite high. The issue of experience, however, is debatable. Most of the trainers have not worked in industry and there are very few 'college – industry' partnership programmes existing. Furthermore, secondment of trainers to industry is rarely practised. Consequently, the possibilities for accumulating hands on experience in the field of maintenance are fairly low. It appears that trainers carry with them a lot of theoretical knowledge but little by way of 'hands on' experience and case studies. The trainers' experience that respondents seem to have referred to is the number of years that trainers have been teaching the subject or topic.

Table 4.3 Level of coverage of maintenance topics in *Technical colleges*

	Topic	MTC[10]			KTC				DIT					TCA	
		ME	ARCH	COMP	ME/ AUTO	CE	EE	COMP	CE	ME	EE	E&T	S&LB	ME	CE
1	Maintenance Organisation	4			1	1	1	1	-	4		3	1	4	3
2	Maintenance Planning	4			1	1	1	1	-	3		3	1		3
3	Project management	-	4	-	-	-	-	-	-	1		4	-	4	
4	Maintenance control	3	-	-	-	-	-	-	-	3		-	3	-	
5	Industrial Safety	4	4	-	4	4	4	4	-	4		3	3	3	5
6	Applied probability and statistics in maintenance	-	-	-	-	-	-	-	1	1		-	1	-	
7	Operations Research Methods in maintenance.	-	-	-	-	-	-	-	1	-		-	1	-	
8	Condition monitoring techniques	4	-	-	-	-	-	-	4	3		-	1	2	3
9	Engineering economics methods in maintenance	4	-	-	3	-	-	-	2	2		-	1	-	
10	Simulation techniques applied to maintenance.	-	-	-	-	-	-	-	1	1		-	1	-	
11	Design of Machine elements	4	-	-	4	-	-	-	-	3		-	3	4	
12	Basic Computer skills in maintenance.	4	-	-	-	-	-	2	1	2		4	1	2	
13	Costing of maintenance.	3	-	-	3	-	3	-	1	3		-	1	4	
14	Supervisory skills for maintenance.	4	-	-	1	1	1	1	4	4		-	1	4	
15	Maintenance techniques for buildings.	-	3	-	-	-	-	-	-	-		-	1	2	
16	Maintenance of water systems.	1	-	-	-	-	-	-	2	-		-	1	4	
17	Maintenance of Roads.	-	-	-	-	4	-	-	2	-		-	3		5
18	Environmental preservation and management.	-	-	-	2	-	-	-	1	3		-	1		
19	Construction Management skills.	-	3	-	-	2	-	-	4	-		-	4		4
20	Repair and maintenance of electronic equipment.	-	-	4	-	-	-	-	-	-	2	-	3		

[10] *Departments of Electrical and Civil Engineering did not participate in the study*

	Topic	MTC[11]			KTC				DIT					TCA	
		ME	ARCH	COMP	ME/ AUTO	CE	EE	COMP	CE	ME	EE	E&T	S&LB	ME	CE
21	Repair and maintenance of electrical equipment	-	-	-	-	-	4	-	-	2	2	-	3		
22	Repair and maintenance of mechanical plants (boilers, machine tools, etc.)	4	-	-	4	-	-	-	-	4		-	1	2	
23	Repair and maintenance of process and chemical plants.	-	-	-	-	-	-	-	-	2		-	1	-	
24	Socio-cultural environment of maintenance	-	-	-	3	-	-	-	-	3		-	1	3	
25	Cleanliness as an aspect of maintenance	4	-	-	4	-	-	-	1	4		4	3	4	4
26	Relation of Maint. Dept. with Production – structural and functional.	4	-	-	4	-	-	-	1	4		-	1	3	
	Others:														
27	Refrigeration and air conditioning (Maint.&repair)				4	-	-	-							
28	Fleet maintenance in road transportation													-	

Key to level of coverage:

Low				*High*
1	2	3	4	5

[11] *Departments of Electrical and Civil Engineering did not participate in the study*

Table 4.4 Level of coverage of maintenance topics in *Universities*

		UDSM				SUA
	Topic / Dept.	CE	ME	CPE	EE	AGRIC&LP
1	Maintenance Organisation	2	4	4	4	Not available[12]
2	Maintenance Planning	-	4	3	3	
3	Project management	4	3	2	2	
4	Maintenance control	-	4	2	2	
5	Industrial Safety	1	4	4	4	
6	Applied probability and statistics in maintenance	-	3	2	2	
7	Operations Research Methods in maintenance.	-	4	1	1	
8	Condition monitoring techniques	-	4	3	3	
9	Engineering economics methods in maintenance	-	2	2	2	
10	Simulation techniques applied to maintenance.	-	1	1	1	
11	Design of Machine elements	-	4	1	1	
12	Basic Computer skills in maintenance.	-	2	1	1	
13	Costing of maintenance.	-	4	2	2	
14	Supervisory skills for maintenance.	-	4	3	3	
15	Maintenance techniques for buildings.	-	-	-	-	
16	Maintenance of water systems.	-	-	-	-	
17	Maintenance of Roads.	-	-	-	-	
18	Environmental preservation and management.	-	2	1	1	
19	Construction Management skills.	5	-	-	-	
20	Repair and maintenance of electronic equipment.	-	-	4	4	
21	Repair and maintenance of electrical equipment	-	-	4	4	
22	Repair and maintenance of mechanical plants (boilers, machine tools, etc.)	-	1	-	-	
23	Repair and maintenance of process and chemical plants.	-	-	-	-	
24	Socio-cultural environment of maintenance	-	1	2	2	
25	Cleanliness as an aspect of maintenance	-	3	2	2	
26	Relation of Maint. Dept. with Production – structural and functional.	-	3	2	2	
	Others: Specify	2	1	-		
27	Refrigeration and air conditioning				-	
28	Fleet maintenance in road transportation				-	

Key to level of coverage:

Low				*High*
1	2	3	4	5

[12] The Department does not have an explicit maintenance course

Table 4.5 Level of coverage of maintenance topics in Training *R&D Institutions*

	Topic	TEMDO	CAMARTEC
1	Maintenance Organisation	4	Not available [13]
2	Maintenance Planning	4	
3	Project management	-	
4	Maintenance control	3	
5	Industrial Safety	2	
6	Applied probability and statistics in maintenance	-	
7	Operations Research Methods in maintenance.	1	
8	Condition monitoring techniques	2	
9	Engineering economics methods in maintenance	3	
10	Simulation techniques applied to maintenance.	1	-
11	Design of Machine elements	5	
12	Basic Computer skills in maintenance.	-	
13	Costing of maintenance.	4	
14	Supervisory skills for maintenance.	4	
15	Maintenance techniques for buildings.	-	
16	Maintenance of water systems.	-	
17	Maintenance of Roads.	-	
18	Environmental preservation and management.	-	
19	Construction Management skills.	-	
20	Repair and maintenance of electronic equipment.	-	
21	Repair and maintenance of electrical equipment	1	
22	Repair and maintenance of mechanical plants (boilers, machine tools, etc.)	3	
23	Repair and maintenance of process and chemical plants.	3	
24	Socio-cultural environment of maintenance	1	
25	Cleanliness as an aspect of maintenance	4	
26	Relation of Maint. Dept. with Production – structural and functional.	4	
	Others: Specify		
27	Refrigeration and air conditioning		
28	Fleet maintenance in road transportation	4	

Key to level of coverage:

Low				*High*
1	2	3	4	5

[13] All topics in the Table do not feature explicitly in courses offered

Table 4.6 **Trainers of Maintenance in Technical Colleges and Institutes of Technology in Tanzania**[14]

	Topic in long course	No. of trainers							Total Trainers
		DIT	MTC (ME)	TCA	KTC	RWRI	TEMDO	CAMAR TEC	
1	Automotive maintenance and repair	1	3		5				9
2	Computer Aided Maintenance		2						2
3	Computer technology, maint. + repair	2							2
74	Condition monitoring techniques	1	7						8
5	Construction Management								
6	Electrical installation	1							1
7	Electrical power utilisation				3				3
8	Environmental preservation and management.								
9	Industrial Safety		7						7
10	Instrumentation	1							1
11	Maintenance control		5						5
12	Maintenance of Drilling rig								
13	Maintenance of Roads.								
14	Maintenance of water systems.								
15	Maintenance Organisation	1	4						5
16	Maintenance Planning	1	5						6
17	Maintenance techniques for buildings.								
18	Operations and Maintenance of water supply systems			1	1				2
19	Plant Maintenance and safety	1		1					2
20	Power systems	2							2
21	Production technology								
22	Project management		7						7
23	Quality control		1						1
24	Repair and maintenance of electrical equipment	2							2
25	Repair and maintenance of electronic equipment.	6			3				9
26	Repair and maintenance of mechanical plants (boilers, machine tools, etc)			1					1
27	Repair and maintenance of process and chemical plants.								
28	Road maintenance	1		3	1				4
29	Supervisory skills for maintenance.		7						7
30	Water quality management					2			2
31	Water resources management					2			2

[14] *Compilation of this data has been difficult because of incomplete information*

	Name of Short Course	No. of trainers							Total Trainers
		DIT	MTC (ME)	TCA	KTC	RWRI	TEMDO	CAMAR TEC	
32	Automotive electrical systems	2							2
33	Biogas technology							1	1
34	Choice, installation, operation and maintenance of manually operated pumping/lifting devices					1			1
35	Computer maintenance	1	1						2
36	Drainage and sewerage					2			2
37	Electrical Fault tracing of Industrial/Domestic appliances		2						2
38	Foundry	2		2					4
39	Hydraulics and pneumatics	2		2					4
40	IC engine / Engine conversion	1							1
41	Maintenance management		2					2	4
42	Management of operation and maintenance in Rural drinking water supply and sanitation					5			5
43	Manufacture of Cinva rams and pumps							3	3
44	Methods of conserving or augmenting water supplies					2			2
45	Motor vehicle Fault tracing and testing		2						2
46	Preventive maintenance		2				3		5
47	Preventive maintenance of pumps					1			1
48	Production and Maintenance Management			3			2		5
49	Production and Maintenance supervisory						2		2
50	Radio servicing / repair	2							2
51	Rainwater harvesting technologies (choice, design, construction, operation and maintenance)					3		2	5
52	Repair welding			2					2
53	Road maintenance			2					2
54	Rural transport facilities							2	2
55	Servicing and maintenance of water pumps					2			2
56	Spare parts design and manufacture						3	1	4
57	Tractor operation and maintenance							1	1
58	TV and Vedio repair	1							1
59	Vegetable oil Press (manufacture and use)							2	2
60	Welding and maintenance of water storage steel tanks					1			1
61	Welding and metal fabrication	2	1						3

4.3 Training methods

There exist a number of training methods that could be deployed to achieve specific results (Figure 4.1). Primarily, the aim of training would be to:

i. Impart knowledge
ii. Change attitude, or
iii. Teach skill(s)

For each of the three specific objectives above, one would deploy specific training methods. Some methods are better suited to impart knowledge than others while other methods are more suited to achieving change of attitudes.

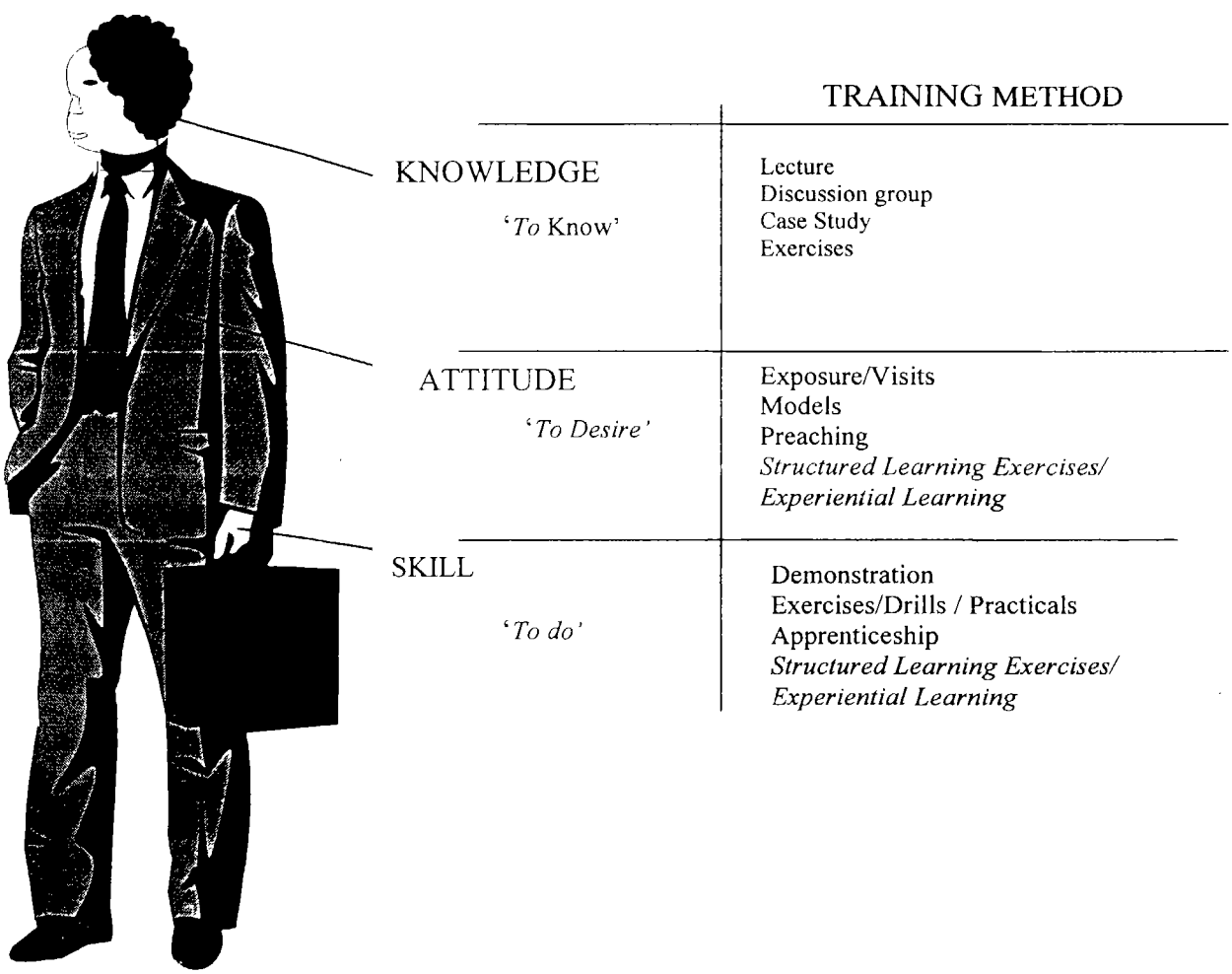

Figure 4.1 Training methods with their appropriate focuses

Maintenance training in all institutions surveyed is done by lecturing and in some cases complemented to some extent with laboratory practicals. Referring to Figure 4.1 therefore, maintenance training in our institutions seem to concentrate on imparting knowledge and not developing skills and/or targeting at inducing a change in the attitudes of the trainees in favour of appreciating maintenance. Consequently, in the majority of instances 'graduates' of maintenance courses come out of the programmes with knowledge about maintenance but often without i) the relevant skills and abilities needed for defining and executing maintenance tasks and functions; and ii) a changed frame of mind of new and relevant set of attitudes and behaviour attaching importance and significance to maintenance. This to us, appears to be the root cause of the apparent substantial cultural dimension of maintenance in the country: the failure of the existing training methods to target squarely and directly at changing the attitudes and behaviour of the trainees in formal sense at the training level.

Table 4.7 **Methods used in Training Maintenance courses/programmes**

INSTITUTION	MAINTENANCE COURSE		TEACHING METHOD(S)	
	Long Course	*Short Course (Sample)*	*Lecture*	Practical
Civil Engineering Dept./FoE	BSc Civil Eng.		√	√
Mechanical Engineering /FoE	BSc Mechanical Egg.		√	√
Electrical Engineering /FoE	BSc electrical Egg.		√	
		Safety and Maintenance	√	
		Maintenance of electronic equipment	√	√
Chem.&Prosess Egg Dept. /FoE	BSc Chemical and Process Egg.		√	√
Karume Technical College	FTC		√	√
		Computer Maintenance	√	√
		Automotive Electrical Systems	√	√
		Repair Welding	√	√
Technical College Arusha	FTC		√	√
		Road Maintenance	√	
		Foundry	√	
		Hydraulics and Pneumatics	√	
Mbeya Technical College	FTC		√	√
		Maintenance Management	√	
		Preventive Maintenance	√	
		Motor vehicle Fault Tracing	√	√
		Electrical Fault Tracing	√	√
		Repair Technology	√	
CAMARTEC		Engine conversion	√	√
		Tractor operation	√	√
		Biogas technology	√	√
TEMDO		Preventive Maintenance Supervisory	√	
		Preventive Maintenance Management	√	
		Spare parts design and manufacture	√	√

Certainly other training methods different from lecturing could be deployed for effective results in moulding behaviour and changing attitudes towards maintenance. Deployment of

experiential learning methodologies that call on student active participation and involvement in generating learning could be an alternative. With experiential learning methodology, the student is made to experience the business of maintenance, its effects, and its problems and possible solutions. Experiential learning as a teaching method has been used with a lot of success in other areas – especially in entrepreneurship development and business courses. It has not been tried in the field of maintenance training. Given the existing poor maintenance performance in the country, it is recommended to consider improvising the method of teaching maintenance courses. Maintenance is about doing. It is important therefore to put emphasis on 'practice' in a maintenance-training course. Current teaching methodology in maintenance covers the 'knowledge' bit and not enough in 'practice'. This seemingly does not produce the desired performance in maintenance practice across the country.

How then can the 'practice' or 'experiential' component be introduced in maintenance courses? One possibility to do this is by introducing models of well-maintained facilities and infrastructure. For example, the Faculty of Engineering could organise to build a "*model well maintained road*" within the premises of the university campus or indeed anywhere in Dar es salaam to be used for maintenance training purposes. This will be a portion of road that will be maintained and monitored by the Faculty of Engineering. Students of transportation engineering in the Faculty will be able use this 'model' road to experience the business of maintenance. They will have access to maintenance schedules, records and costs of maintenance.

The research team discussed this idea with a few other training institutions. The idea did not seem to be well received by some institutions. It sounded to them like a very new and fairly innovative idea. As a project, it is likely to cost substantially, hence the difficulty in implementing such a proposal. The project will demand excellent networking with the Dar es salaam City Commission and the Ministry of Works. There will definitely be issues of "whose responsibility it is to maintain roads in Dar es salaam" – relevant Government Ministry of Local government authorities, for example.

4.4 Summary

All engineering courses offer components dealing with the subject of maintenance. The content and emphasis of maintenance in the various courses vary. Some institutions put more emphasis on maintenance than others.

Both short and long courses on maintenance are conducted in the institutions surveyed in this study. Some institutions were more successful in conducting the courses than others.

Generally, the marketing of maintenance short courses has been reported to be a difficult issue by most institutions. Some institutions like Rwegalurila Institute of Water Resources reported failing to attract enough participants for their short courses. This has been attributed to the current difficult economic condition resulting in people not having money to spend on training.

There are a number of maintenance trainers in the Institutions surveyed. Staff numbers in maintenance is not a problem. The experience component, however, is not so good as most trainers have not had an opportunity to work in industry. 'Industry-University/College' collaborative programmes are almost not existing.

Lecturing is the most commonly practised teaching methodology in maintenance courses. However, lecturing is more suited to imparting knowledge than to imparting skills and changing behaviour or attitudes. It is the changing of behaviour and attitude of the trainees that is the most critical issue in maintenance training. Accordingly, the thrust and orientation of maintenance training in the country would need to be re-designed to take into account this urgent need.

Chapter 5

Capabilities and Weaknesses in Maintenance Training

5.1. Human Resources

Training of maintenance personnel is a basic strategy for promoting and developing maintenance capabilities in a country. This training should be a life-long process in order to keep up with the constantly changing technological, economical and social environment in the country. The training should be centred around two broad areas:

(i) Training of technical personnel especially engineers, technicians and artisans directly involved in the maintenance of plants and infrastructure facilities.

(ii) The sensitisation of industrial and public managers, i.e. those managing industrial operations, those working in the government and umbrella institutions and dealing with policies and planning of industrial development and public infrastructure facilities.

In Tanzania, both of the above mentioned categories of training are carried-out mainly by the training institutions identified in Chapter 3 which has listed the institutions surveyed in this study carrying out maintenance training - both short term courses and long term ones.

Table 5.1, summarises the important qualifications and skills that need to be possessed by staff teaching maintenance.

Table 3.2 (Chapter 3) presented facts and figures on the teaching staff at the above maintenance training institutions. Generally, the institutions have programmes to train maintenance personnel of major categories required by the industries and infrastructure. Furthermore, there is emphasis on both long and short courses. The number of staff at each institution is adequate and also the staff is generally academically qualified. However, in most cases the staff does not have adequate practical experience in maintenance. For example, and as indicated in chapter 4 whereas the majority of maintenance trainers at University institutions (FoE/UDSM and AE/SUA) are PhD holders, they do not have sufficient practical experience. Trainers at technical colleges, especially DIT, TCA and MTC

have largely Masters degrees and ordinary diplomas and have better practical maintenance experience.

The study has observed (see Table 3.2, in chapter 3) that there is a small number of institutions engaged in maintenance training in the country and that the emphasis in those programmes is largely theoretical as opposed to practical training approach especially at the institutions training engineers and technicians. The latter problem mirrors the lack of practical experience among the trainers as was observed above. The small capacity for training maintenance technicians is worrisome.

The combined number of maintenance trainers at the degree, diploma and technicians training institutions is about 105, which is very small in relation to the country's total population of about 30 million. It should however be cautioned that the number of those directly qualified to teach maintenance as per the criteria in Table 5.1 is much smaller. Figure 5.1 shows the pattern in the distribution of the trainers by areas of specialisation: mechanical, general civil, electrical, and electronic and telecommunications, roads, water and agricultural, chemical and process engineering fields. It is observed that maintenance trainers in the chemical & process, civil, electrical and electronic fields are very few at the degree, diploma and technician training levels. The mechanical engineering specialisation seems covered although the extent is not enough considering the needs of the whole country.

Table 5.1 Required Qualifications and Skills of Maintenance Trainers

S/N	Level	Qualifications and Skills
1	Engineers' training	A BSc degree in a relevant engineering field At least a MSc degree in maintenance management or related area At least five years of practical experience in maintenance
2	Technician training	At least a BSc or Advanced Diploma in the relevant engineering specialisation At least five years of industrial experience in maintenance A short course in maintenance management
3	Vocational training	At least FTC in a relevant engineering field At least 3 years of relevant practical maintenance experience A short course in maintenance management
4	Practical short courses	For managers - See (1&2) For engineers - See (1&2) For technicians - See (1&2) For artisans - See (1&2,&3)

All degree and FTC-level maintenance training institutions are located in only 4 of the 25 regions of the country. The lucky regions are Dar es Salaam, Arusha, Mbeya, and Morogoro. The rest of the country does not have easy access to maintenance training. This is especially significant when offering short maintenance courses for industry and other local organisations. Clearly, there is need to develop more maintenance trainers and training institutions to cover the total demand in the country and in the other regions which are not presently not adequately covered.

Considerable efforts have been made at the artisan training level through the dynamic role of VETA.

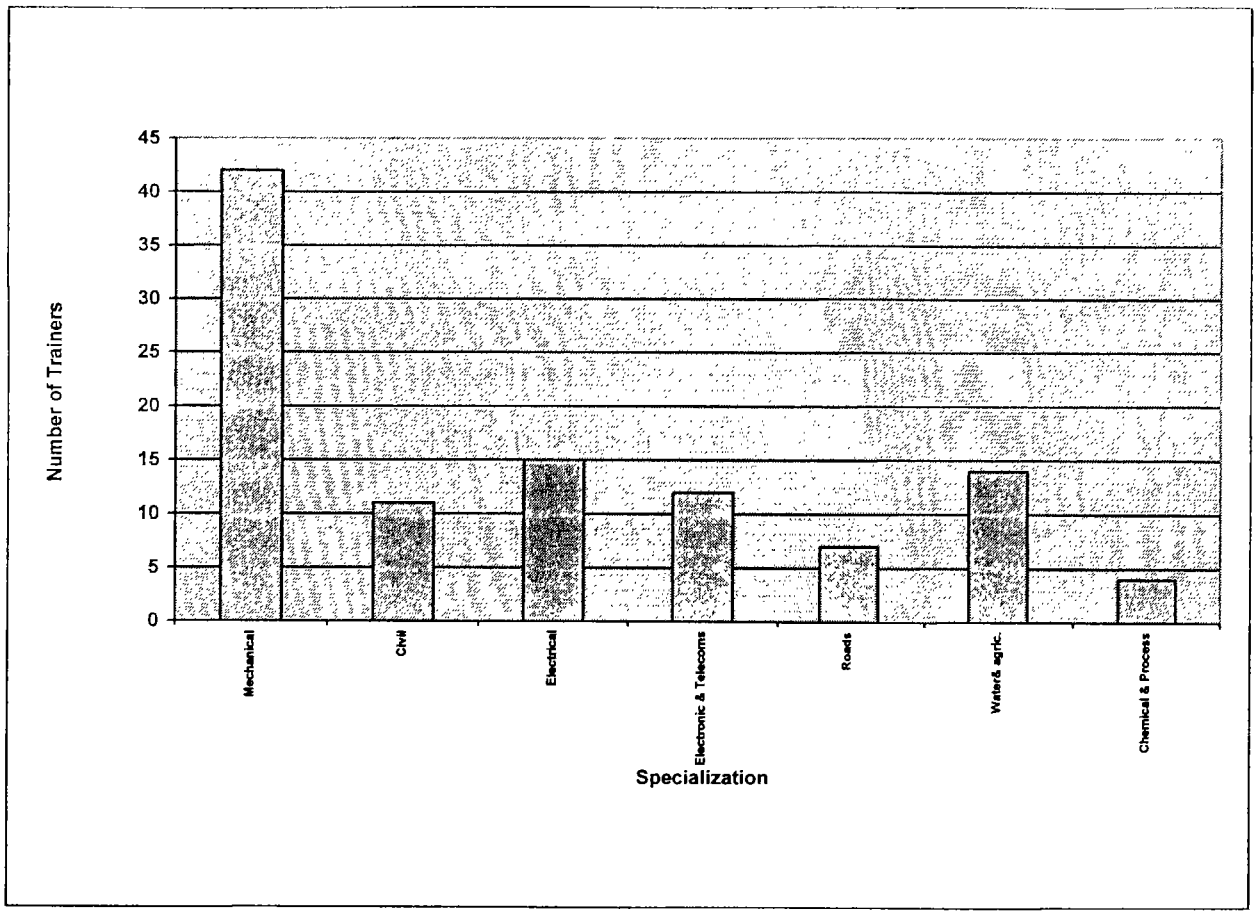

Figure 5.1 Maintenance Trainers in Tanzania

5.2. Curricula Design, Content and Delivery

5.2.1 Curricula Design

Table 4.1 and Table 4.2 (Chapter 4) is an overview of how the existing curricula at the surveyed institutions were designed. As can be seen from Table 4.1, all long programmes are part of regular training of engineers, technicians or artisans. The programmes have been developed in accordance with the respective institution's formal curricula development process for long programmes. However, the technical colleges complained that they do not have effective control over curriculum development. The parent Ministry provides the curricula to them. Officials of the parent ministry however, disputed this claim by some

technical colleges. This points out to the fact that there is not enough communication between the colleges and the parent ministry on the issue of curricula design and implementation.

There is no explicit long-term training of engineers, technicians and artisans leading principally to explicit maintenance certification, e.g., BSc in Road Maintenance Engineering. One reason behind this sad state of affairs could be that the existing long programmes don't appear to have been informed by carefully done studies of the needs of industry and developers public infrastructures. The situation is different in the case of the R&D institutions like TEMDO and CAMATEC as was explained in Chapter 3. TCA is the other exception.

The maintenance courses in the existing long programmes do not appear to receive priority attention. The very short duration of such courses in these programmes illustrates the point. The duration of maintenance courses ranges from 40 to 84 contact hours in the case of degree programmes; from 60 to 240 contact hours for technician training programmes and about 60 hours for vocational training programmes. These amounts of hours do not allow for adequate maintenance training.

It is noted that given the tightly packed long programmes at FoE, SUA, DIT, TCA, and MTC students wishing to undertake advance studies in maintenance can not do so while in these programs. It is therefore necessary that maintenance management and engineering should be established as one of the specialisation at diploma, degree and postgraduate levels. The programs should be intended to provide a cadre of engineers and technicians rigorously trained to handle complex maintenance engineering and management problems.

The variety of maintenance courses, offered as part of the long programmes, is not adequate. Important areas such as computer-assisted maintenance, quantitative aspects of maintenance, costing of maintenance, environmental management aspects of maintenance, repair of large mechanical and chemical plants are not significantly covered.

While the present target groups, i.e., engineers, technicians, and artisans are relevant, there is need for more courses on maintenance appreciation and management offered to people in non-engineering fields such as business administration, education and public administration.

The graduates for the latter fields are the ones who become administrators, managers and policy makers in government and industry. They therefore become directly responsible for making decisions for and overseeing large investments in infrastructure facilities and plants.

The maintenance courses especially those under the above-mentioned long-programmes (Table 3.2 in chapter 3) are designed to be mainly theoretical. This is a bit worrisome since maintenance is essentially a very practical problem whose teaching has to be significantly problem- and practice-based.

The short courses (Table 4.2 in Chapter 4) in most cases have duration ranging from 2 to 4 weeks. This duration is about the norm for short courses in the country.

Most of the training institutions indicated that they develop short courses on the basis of available in-house expertise. Only the TCA and KTC out of the institutions surveyed do actually develop short courses on the basis of a systematic market research. It is not surprising therefore, that for the majority of the institutions performance of the short courses has been very discouraging. The research team could not establish a regularly repeating short course in maintenance at any of the institutions. Furthermore, many of the short courses planned by the institutions could not be conducted mainly for lack of applicants. It is the opinion of the research team that designing, planning and marketing of short courses in maintenance is presently a very weak area in all the institutions covered in this study.

Presently, there is no graduate programmes in maintenance in place in the country. We only have one course in the Masters programmes in Engineering Management and Industrial Engineering at the University of Dar es Salaam which include a course in maintenance management.

The apparent lack of effective links between the training institutions and other local, regional and international institutions in maintenance is a significant disadvantage. This may be contributing to perpetual in breeding. Links are effective for exchanging information on curriculum, staff exchange and joint programmes. Where such links exist, e.g. at TCA, positive benefits are self-evident.

5.2.2 Curricula Content

Tables 4.3 and 4.4 (chapter 4) show the levels of coverage of essential maintenance topics by the Universities and Technical Colleges. The tables basically reflect the extent to which basic maintenance topics are generally covered by the training institutions. These are topics relevant to the environment of the country (See Table 5.2). The table indicates major areas of strength and weaknesses of the existing maintenance curricula in the country.

Table 5.2 Maintenance Topics Relevant to Tanzania

Maintenance Areas	Maintenance Topics
Maintenance and Cultural Management	Maintenance Organisation, Maintenance Planning, Project Management, Maintenance Control, Supervisory Skills for Maintenance, Social & Cultural Environment of Maintenance, Relation between the Maintenance Function and Other Organisation's Functions.
Quantitative Methods in Maintenance	Applied Probability and Statistics in Maintenance, Condition Monitoring Techniques, Engineering Economic Methods in Maintenance, Costing of maintenance.
Computer Assisted Maintenance	Basic Computer Skills for Maintenance
Industrial Safety	Safety Management, Machine Hazards
Environment Management	Environmental Preservation and management
Design for Maintenance	Design of Machine Elements & Machines; Building Design
Construction, Building & Roads Maintenance	Maintenance Techniques for Buildings and structures, Maintenance of Water Systems, Maintenance of Roads, Construction Management skills.
Electrical & Electronic Maintenance	Repair and Maintenance of Electronic Equipment; Repair and Maintenance of Electrical Equipment.
Mechanical & Chemical Plant Repair	Repair and Maintenance of large Mechanical Plants (boilers, machine tools, etc.), Repair and Maintenance of Chemical and Process Plants.

The curricula of most training institutions significantly cover Maintenance Management, Quantitative Methods of Maintenance, Industrial Safety, Design Aspects of Maintenance and Maintenance of Buildings and Roads. Shortfalls are in Computer-Assisted Maintenance, Environmental Management, Maintenance of Electrical and Electronic Equipment, Repair of (heavy) Mechanical and Chemical Plants.

With the increasing trend towards greater use of electronics and computerised systems in plants and equipment, greater emphasis on training of electronics and computer maintenance engineers and technicians is required.

What is completely missing is the training of chemical and process engineering technicians and artisans. There is need to consider training technicians who can handle electrical and mechanical problems at the same time. Most plants in industry are electro-mechanical systems and given the small size of many companies, having very specialised engineers and technicians is too expensive.

5.2.3 Curricula Delivery

The study has shown most of the training institutions use the following modes of teaching in both their long and short courses:
(i) Lecturing
(ii) Practical training in industry (for long programmes)

But the following methods are used only to a much lesser extent.
(i) Practical exercises in laboratories and workshops
(ii) Structured simulation exercises
(iii) Analysis of practical maintenance case studies
(iv) Field visits to industry and relevant infrastructures (buildings, roads, etc.)
(v) Maintenance projects
(vi) Audio-visual means (educational films, slides, videos)

It is important to point out that, given the practical nature of maintenance, the lesser-emphasised methods are the more relevant ones. We have in mind particularly field visits, practical maintenance exercises, maintenance projects and the like. As also observed in Chapter 3, presently no training institution is making use of engineers from industry to teach some of the maintenance courses. Staff exchange between the training institutions and the relevant local industry needs to be promoted and supported.

At the FoE and DIT as part of efforts to improve delivery, lecture manuscripts have been prepared for most courses including maintenance. These are efforts that should be extended to cover the other institutions. In all institutions, there was a general lack of modern laboratories dedicated to the demonstration of important maintenance techniques and practice such as condition monitoring.

The survey revealed that out of the 27 subjects/topic areas expected to be covered during the training only 5 areas are dealt with strongly. These areas include:

- Maintenance organisation
- Maintenance planning
- Project management
- Industrial safety
- Design of Machine elements.

5.3 Sustainability and continuity of the Training Programme

The survey has shown that in all institutions the training programmes are not sustainable neither are they able to cope with the modern technology. Also other factors affecting the institutions are financial aspects when it comes to fees payment as clients cannot afford to pay for such training.

5.4 In - House Physical Facilities

The importance of having adequate and appropriate physical facilities (workshops, literature, etc.) for maintenance training can not be over emphasised. Table 5.3 presents the situation of physical facilities in technical colleges and university covered in the survey. It can be seen that:

(a) The FoE/UDSM, DIT and TCA are the most endowed.

(b) There are no deficiencies of facilities for demonstrating maintenance techniques.

Table 5.4 Maintenance Facilities at Each Training Institution

Technical College Arusha				
Mechanical Engineering				
	Lab. / Workshop	**Quantity**	**Student capacity**	**Adequacy for training**
	Production Machine Shop/Lab	1	16	YES
	Materials Testing	1	16	YES
	Hydraulics and pneumatics lab	1	30	YES
	Foundry	1	8	YES
	Heat treatment Lab	1	8	YES
	Forging	1	8	YES
	Welding shop (Arc, Gas, TIG/MIG	1	16	YES
Civil Engineering				
	Building Materials	1	16	YES
	Transportation and Highway and Soil Lab	1	25	YES
	Surveying Facility	1	30	YES
Electrical and Electronic Engineering				
	Electronic Lab	1	12	YES
	Electrical Machinery	1	12	YES
	Measurement and control	1	16	YES
	Motor rewinding	1	-	YES
	Electrical installation	1	20	YES
Dar es Salaam Institute of Technology				
Mechanical Engineering				
	Facility	Quantity	Student Capacity	Adequacy for Training
	Design Facilities	6	30	YES
	Production Machine Shop	5	20	YES
	Material Testing	1	20	YES
	Air Conditioning	1	30	YES
Civil Engineering				
	Soil and Foundation	1	30	YES
	Surveying	1	30	YES

Faculty of Engineering, University of Dar es Salaam				
Mechanical Engineering				
	Lab. / Workshop	**Quantity**	**Student capacity**	**Adequacy for training**
	Design Facilities	5	40	YES
	Production Machine Shop	1	40	YES
	Material Testing	1	40	YES
	Engine Turbo Machinery	1	40	YES
	Air conditioning	1	40	YES
	Hydraulics	1	40	YES
Civil Engineering				
	Soil & Foundation	1		
	Building Materials	1		
	Structural Design	1		
	Hydraulic Eng. Lab	1		
	Transport & Highway lab	1		
	Surveying	1		
Electrical & Electronics				
	Facility	Quantity	Student Capacity	Adequacy for Training
	Computer Facility		20	
	Electronic Lab		20	
	Electrical Machinery		20	
	High Voltage		20	
	Telecommunication		20	
	Structural analysis		20	
Karume Technical College				
Mechanical Engineering				
	Facility	Quantity	Student Capacity	Adequacy for Training
	Design Facility	1	23	YES
	Production Machine Shop	3	16	YES
	Air Conditioning	1	16	YES
Electrical & Electronics Engineering				
	Computer Facility	1	14	YES
	Electronics Lab	1	10	YES
	Electrical Machinery	1	10	YES

In general all institutions have to improve the situation of facilities. Each needs to acquire (a) informational resources for maintenance training as for example books, journals etc modern maintenance training equipment in their laboratories and workshops; (c) audio-visual equipment for maintenance training (videos, films, training models, etc.).

5.5 Graduates Employment trends

The major employer of the graduates is the Government through its ministries. Ever since the Government stopped employment, a number of graduates have not been able to get employment. But with the present growth of private industries in Tanzania, it is envisaged that maintenance graduates will get employment. In some institutions like DIT and FoE courses in entrepreneurship have been introduced to assist graduates in becoming self-employed.

5.6 Financial Resources

Table 5.5 indicates the main sources of financial support for the training institutions. All of the institutions indicated that their maintenance training activities are constrained by financial problems, among others. In all of them the amount of financial resources coming through conducting short courses in maintenance is practically negligible. Also, the government and donor sources of funding are declining at most institutions. This means that at the present moment funding is one of the major bottlenecks facing training institutions in the country. It is a problem that needs to be addressed in an innovative manner.

Table 5.5 Financing Maintenance Training

	Fees	Donors	Government Sources
SUA	L	-	M
CAMARTEC	L	M	L
TEMDO	L	M	L
DRVTSC	L	H	L
KARUME	L	-	M
DIT	M	L	M
TCA	M	M	M
FOE-UDSM	L	H	M
MTC	L	-	M
RWI	L	-	M

Key: L – low; M- medium; H- high

PART THREE

SUMMARY, IMPLICATIONS AND RECOMMENDATIONS

This final part summarises the main findings of the study. It then draws some important implications of a policy and planning nature from the findings. It ends by putting some recommendations on what needs to be done in the future to improve the training of maintenance personnel in Tanzania. This part is organised in a single chapter.

CHAPTER 6

6.1 Main Findings and Conclusions reached in the study

This study has examined the nature and extent of training of maintenance personnel in Tanzania. Within this broad objective the study aimed at:

⇒ compiling and developing an inventory of institutions which conduct maintenance training in the country.

⇒ examining the nature and extent of maintenance related programmes designed and put in place in the training institutions surveyed.

⇒ to compile and develop a list and profile of maintenance trainers in the institutions studied, and

⇒ to document and describe strengths and weakness associated with maintenance training within the institutions surveyed.

The field survey of the study has come up with a number of interesting and important findings. The main ones are described in the subsections below.

6.1.1 **Maintenance training institutions**

The study (chapter 3) has revealed that there exists a number of institutions in Tanzania engaged in the training of maintenance personnel. The majority of these (eg R&D institutions and Vocational schools) handle short courses lasting about two to six weeks. These courses target operatives at artisinal, technician and related levels in the plants. Teaching institutions (e.g. University of Dar es Salaam, Sokoine University of Agriculture, Dar es Salaam Institute of Technology) do offer maintenance training courses on a somewhat long term basis (say 6-9 months) and often handled as part and parcel of the formal engineering training programmes they offer. At the same time, the study revealed that there are no training institutions in the country conducting maintenance training programmes at graduate level.

6.1.2 Capacity for maintenance training

Chapters 3, 4 and 5 of this report has documented on the superior human resource capacity (both in terms of numbers and qualifications) of the staff conducting maintenance training in the institutions surveyed. In fact, the study suggest that there is an obvious over capacity in respect to human capital in relation to the existing training load - in almost all institutions surveyed. On the other hand the study revealed some weakness in human capacity in terms of professionalism as a function of practical, field or industrial experience of the teaching staff. At the same-time, it is reported that in some of the training institutions (e.g. the R&D institutions, Mbeya Technical College etc) capacity in terms of physical facilities (e.g. laboratories, workshops etc) and even teaching literature is weak and needs reinforcing. Thus in respect to capacity in terms of human power there is an apparent over-capacity in most of the institutions surveyed; and at the same time there is under capacity in terms of physical facilities in many of the institutions surveyed.

6.1.3 Curriculum design and content

It was revealed in this study (especially in chapters 3 and 4) that the training institutions surveyed have curricula and programmes which relate to subjects of maintenance in place. Common subjects covered in the curricula include, for instance, automotive maintenance and repair, engine tuning, machine installation etc. By and large an overwhelming proportion of the curricula focus on maintenance of mechanical, civil and structural equipment and other related artefact.

The curricula and programmes give relatively little attention to maintenance aspects of key areas like electrical and micro-processor operations and applications. Furthermore, in the majority of cases - especially in the case of those training institutions under the auspices of the Ministry of Higher Education, the curricula tend to be static and rigid rather than flexible and evolutionary. The experience shows that generally maintenance curricula upgradation, improvement and adjustment in the institutions fell far behind the objective needs and demands of the local economic structure. The study reports that, by and large, the curricula in place are in some important respects out of touch with the realities of the needs of the users - industry primarily. And that there appears to have been no active effort and initiative on the part of the training

institutions to shape and design their training programmes in the light of the objective needs of the market - industry.

6.1.4 Training approach

The primary objectives of maintenance training in the institutions covered in this study have been very well described in Chapter 4. These objectives include: instilling maintenance skills and expertise in the trainees, instilling knowledge about maintenance on the trainees, and to achieve a change in attitudes, behaviour and thinking on the trainees in favour of maintenance. That is, to change the mindsets of the trainees so that they can become more sensitive to maintenance.

It was also pointed out (Chapters 4 and 5) that the most common training approach used in the institutions surveyed was lecturing which was in some cases supplemented by practicals and laboratory work. The instructor or lecturer was the main actor, while the trainees being more or less at the recipient end. The field survey of the study has also picked two particular aspects of the training approach in use in the training institutions studied. First much of the training did not involve staff (operative, supervisory and management) in industry. In this sense, the approach has been less interactive and participatory with industry. Second, the training by and large, did not draw on the working experience of the trainees themselves. The approach did not capitalize on the tacit and practical knowledge of the trainees - through experiential learning situation and/or through simulation, and proto type/model building.

6.1.5 Funding

In the majority of the training institutions surveyed lack of reliable and long term funding presented itself as a problem inhibiting sustainability of the programmes - especially the short courses. Many of the training institutions surveyed do not have adequate financial resources for conducting maintenance programmes. Much of the little financial resources they have comes from foreign donors. To an extent, the deep financial problems the training institutions face reflects the limited importance production firms attach to plant maintenance and maintenance training.

6.2 Strengths and Weaknesses

Strengths of the institutions studied were assessed in terms of qualifications of the trainers academic as well as practical or industrial experience, the use of industrial managers to supplement practical inadequacies, physical facilities such as laboratories, etc, curriculum development and content and to some extent funding programmes for sustainability. The study revealed that there is no one institution which can claim to have a concentration of all these. The faculty of Engineering of the University of Dar es Salaam, for example has a high score in academic excellence of its trainers but very low in industrial experience. As a result their teaching is 100% theory. The balance between theory and practice differs within the three technical colleges. KTC and MTC have more theory than practice 40% to 80% versus 60% - 20%. DIT likewise has 40% of its long term time for theory in telecommunication and mechanical engineering, and 90% theory for electrical engineering.

Maintenance training, particularly preventive maintenance requires the use of laboratory facilities as well as simulations of situations. The survey findings revealed that there is a general weakness of such facilities in the training institutions. Where such facilities exists they require updating in technology.

6.3 *Implications and Recommendations*

Based on a summary of the main findings of the study as given under section 6.1 above, a number of implications are drawn and recommendations made. These are outlined below.

6.3.1 **Capacity matching and capacity utilization improvement**

Given that there exist a mismatch between human resources capacity and physical capacity (eg laboratories, workshops etc) in some of the training institutions surveyed it is recommended that efforts be made to upgrade the physical capacity in order to balance the two sets of capacities. Granted that such a balancing programme is implemented, the capacity of the training

institutions will be enhanced. This will enable them to handle more trainees. It is thus recommended here that the relevant authorities to which the training institutions belong (eg Ministry of Science, Technology and Higher Education in respect to the Technical Colleges, UDSM and SUA, Ministry of Industry and Commerce in respect to TEMDO and CARMATEC; Ministry of Youth and Labour in respect to DRVTSC) take the appropriate steps to balance and upgrade capacities within the training institutions.

6.3.2 Flexibility and proactivity in curriculum design and execution

A good deal of industrial activities and processes are dynamic and flexible. This is also the case in the Tanzanian situation. Given the fact that much of the curricula and programmes in place in the training institutions surveyed may be by and large out of tune with the objective needs and demands of the market, conscious efforts, should be made to relate dynamically the training programme design to the needs of industry as they change and evolve over time. To do this sustainably would require that:

(a) the training institutions be given full authority in the design of curricula and their subsequent improvement as may deem necessary and appropriate.

(b) the training institutions should develop sensitive and effective anthenas for picking up signals on the market on training needs of industry. That is, training institutions must constantly 'hear the market' and respond to it appropriately and on time.

(c) training institutions, in collaboration with other 'stakeholder groups' in the field need to carry out regularly more systematic assessment survey on needs of maintenance training in the local economy.

6.3.3 Training methods and approaches

Given that maintenance training is aimed at achieving skills acquisition; knowledge accumulation and attitude and behavioral change on the trainees; and that different training methods may be used to achieve different training effects; it is hereby recommended that:

(a) a judicious combination of training methods (eg formal lecturing, practical training, experiential training, simulation analysis, trainees involvement etc) be used in order to maximize on the training effects or results on the trainee - ie so that the trainee at the end of the process acquires not only maintenance skills but also maintenance knowledge and a new mind set which provides for the appreciation of the need for maintenance.

(b) involvement of industry staff (plant supervisors, managers etc) in the training of maintenance in a formal and on regular basis. This may be worked out on the basis of a formal training institution/industry partnership arrangement.

6.3.4 New areas for maintenance training

For some reasons much of current maintenance training focuses on mechanical processes and installations; and on civil engineering and building structures and facilities. Given the growing application of electrical, microprocessor and instrumentation devices to industrial operations and processes it is imperative that maintenance curricula design and training should put particular emphasis in this area. Likewise, as chemical and processing activities are increasingly becoming an important part of the industrial scene in the country, it would be important to take care of this subject in curriculum design and training of maintenance in the future in the country.

6.3.5 Funding for maintenance training

Since reliable funding for maintenance training constitutes a perennial problem in practically all the training institutions surveyed it is hereby proposed that producing firms set up adequate revolving maintenance training funds. These funds could be financed through a variety of ways for example, from company profits, employee contributions, donations and so forth. The funds would be the prime source of financing maintenance training for the companies.

6.3.6 Maintenance sensitization programmes

Together with the need to develop a plant's relevant personnel with the knowledge, skills and mental frame relevant for maintenance, there is also the urgent need to design and implement

good maintenance sensitization programmes for various types of personnel in plants and leadership in society. The entire workforce in a plant must be sensitized to the need and importance of maintenance. So should the national leadership - policy makers, planners, strategists etc if maintenance training effectiveness and performance has to be enhanced - both within plants and in society in general.

Maintenance courses for the non-maintenance personnel in a plant, policy makers and community leadership are envisaged to greatly enhance maintenance performance in industry and community infrastructure.

6.4 Directions for future research

The findings of this study point to interesting directions for future research in the field of maintenance and development. A couple is outlined below:

6.4.1 **Studies of non-maintenance**

An implied assumption of this study is that good maintenance performance is a source of improved performance of a given plant. But given the nature of industrial processes in many developing countries, this truth may not easily and always be self-evident. An interesting serendipity was noted when the Head of Mechanical Engineering Department of the FoE, University of Dar es Salaam told the research team that Managers of Private firms did not favour training their workers in maintenance because they thought it was a loss making venture. Maintenance technicians would recommend the purchase of spare parts that they would sell to make money. It is thus proposed that more in-depth and systematic studies be carried out on the direct and indirect costs that firms and countries inevitably incur as a result of not carrying out proper maintenance. Such costs may include loss of market shares to a firm, loss of vital services like health, education, transport and other amenities to community etc. A systematic documentation of the pathological effects of non-maintenance would have a lot of impact on raising consciousness for the need of maintenance training within individual plants and in societies.

6.4.2 Studies on the demand of maintenance personnel

As indicated earlier (Chapter 1), this particular study focuses on the supply side of maintenance personnel (i.e. the aspects of training for maintenance personnel). It would be pertinent to carry out more systematic studies on the use of maintenance staff within user plants. What roles are given to such people in plants, other organisations and in the government service; what are the environments like under which the maintenance staff operate in plants etc. Systematic and well rounded empirical studies of this kind will shed a lot of light on the effective engagement (or otherwise) of maintenance personnel in plants.

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Appendix 1 SWOT Analysis of Institutions for Training Maintenance Personnel

STRENGTHS:

CRITERIA	DRVSC	CAMARTEC	TEMDO	KTC	MTC	TCA	DIT	SUA	FOE
STAFFING	• Trainers experienced (90 in number) • Four instructors specialised in maintenance	• long experience: over 15 years • well trained staff (3 staff)	• trainers have over 10 years experience • 5 staff all with BSc	• Competent staff (15 in number)	• Highly Qualified staff (14 in number) • Experienced Staff. • Experienced technical staff in labs	• Staff have adequate academic skills(BSc)and Diploma (5 staff in number) • Staff have enough practical experience (20 years) • Some good experience technical staff in labs and works labs	• Academically and practically experienced trainers (40 trainers) • staff have good maintenance teaching experience • A good number of practically qualified technical staffing in labs and practical skills • Most staff have ADE, Masters	• High academic staffing qualifications (9staff with PhDs)	• Highly qualified academically (17 trainers) • All PhD level staff • Good maintenance • A good number of qualified technical staff in workshops /lab
COURSES	• Well established long programmes for artisans • High training capacity (400 students) • Practical courses	• Tailored short courses		• Tailored short courses with substantial practical content	• Short course run 7 times a year, successful • Well established long programs for FTCs and ADE	• long programmes at FTC and ADE (well established)	• Well established long programs at FTC and ADE		• Well established long programs leading to BSc (Eng.) in EE, ME, CE & CPE • MSc programs with maintenance relevant subjects • labs and models for teaching
FACILITIES AND LOCATION	-	-			-	Well equipment lab (adequate)	• Well equipped laboratory and workshop • strategically located	-	• Well equipped labs and workshops

CRITERIA	DRVSC	CAMARTEC	TEMDO	KTC	MTC	TCA	DIT	SUA	FOE
ORGANISATION	•	• Adverts on courses conducted effected. • Links with other vocational Institutes		• Adverts done through ministry Journals News papers & TV			• new more autonomous institute since 1997	• Advertise courses by distributing brochures	
SUSTAINABILITY	For long programs				Programs sustainable	Long programmes sustainable	Long programmes sustainable	Long programmes sustainable	Long programmes sustainable

WEAKNESSES

CRITERIA	DRVSC	CAMARTEC	TEMDO	KTC	MTC	TCA	DIT	SUA	FOE
STAFFING	○ Only four experts available ○ only one with Degree ○ mostly with TTI	○ lack of funding for training ○ Low staff remuneration	○ too few staff ○ staff mainly qualified in design engineering ○ Low staff remuneration	○ Low staff remuneration	○ shortage of staff	○ Low staff remuneration	○ Low staff remuneration	○ staff lack practical experience ○ maintenance awareness very low	○ lack of strong attitude toward s maintenance ○ staff not practically experienced ○ Low staff remuneration
COURSES	○ lack of documented maintenance curricula	○ lack of market analysis of programmes ○ No long term programmes	○ Poor funding	○ Short course not based on demand ○ Curriculum not reviewed for many years	○	○ Poor promotion of courses	○	○ No short courses conducted ○ Long programs not strong in terms of maintenance	○ Poor promotion of courses ○ Financial implications not covered ○ Awareness of programs low ○ Course contents not practical ○ Course too theoretical
FACILITIES AND LOCATION	○	○ No transport	○ poor facilities	○ Lack of adequate equipment	○ lack of facilities for demonstrations	○ poor reference sources ○ Insufficient training materials	○ Lab space too limited ○ Lack of up to date text books ○ ageing facilities	○ Lack of w/shop & labs ○ lack of maintenance facilities	○ poor maintenance of facilities
ORGANISATION	○	○	○ No links with other Institutes	○ No links with other Institutes	○ No links with other Institutes	○ No links with other Institutes ○ Maintenance not part of job descriptions ○ No awareness programmes on maintenance	○	○	○ poor timing of short courses
SUSTAINABILITY	○ Poor market research of courses	○ Poor market research of courses	○ Poor market research of courses	○ Poor market research of courses	○	○ Poor Budgeting	○ No funding		○ Poor attendance ○ Teaching should be done by people from Industry

OPPORTUNITIES:

CRITERIA	DRVTSC	CAMARTEC	TEMDO	KTC	MTC	TCA	DIT	SUA	FOE
STAFFING	• Availability of practical training in industry for staff • Easy to use industry engineer to teach	• Specialised in agro. Machinery • Staff training done in-house				• Easy to use industry engineer to teach	• Use industry engineers to teach	• Training opportunities in agricultural and irrigation areas	• access to body of research that can enhance maintenance teaching • use industrial engineers to teach
COURSES	• VETA mission is supportive of maintenance training at craft level		• Mission support emphasis on design engineering aspects of maintenance		• Mission is to produce practical-oriented people • Suitable for middle level experts	• Mission is to produce practical oriented people • Suitable for middle level experts	• Mission is to produce practical oriented people. • Suitable for middle level experts	Mission suitable for training high level maintenance experts	• Mission suitable for training high level maintenance experts
FACILITIES AND LOCATION	• General infrastructure is available	• Facilities available • tools • workshops • - testing	• Building space	• General infrastructure is available • Opportunities in Zanzibar	• General infrastructure is available • Opportunities in Mbeya and Iringa	• General infrastructure is available • Opportunities in Arusha & Moshi	• General infrastructure is available		• General infrastructure is available • Opportunities in Dar es Salaam
ORGANISATION	• VETA framework is very supportive	• Linkages with other institutions	• Linkages with other institutions			• leadership very committed promoting maintenance • Linkages with other institution	• leadership very committed promoting maintenance • Presence of Industrial liaison officer • Industrial personnel teaching on part time basis • Government policy regarding part time is present		• Presence of Industrial Relations Office and Bureau for Industrial Co-operation • University Institutional Transformation programmes will improve all areas of the UDSM
SUSTAINABILITY	Labour market demand for artisans				• increased government funding	• increased government funding	• increased government funding	• increased government funding	• increased government funding

THREATS:

CRITERIA	DRVSC	CAMARTEC	TEMDO	KTC	MTC	TCA	DIT	SUA	FOE
STAFFING	○ poor remuneration of staff	○ poor remuneration of staff	○ poor remuneration of staff	○ poor remuneration of staff	○ poor remuneration of staff	○ poor remuneration of staff	○ poor remuneration of staff	○ poor remuneration of staff	○ poor remuneration of staff
COURSES	○	○			○	○			○
FACILITIES AND LOCATION	-	-			-		○		○
ORGANISATION	○	○		○			○	○	
SUSTAINABILITY	○ donor dependency	○ donor dependency ○ low ability of participants to pay ○ insufficient govt funding	○ donor dependency ○ low ability of participants to pay	○ low ability of participants to pay ○ insufficient govt funding	○ low ability of participants to pay ○ insufficient govt funding	○ donor dependency ○ low ability of participants to pay	○ low ability of participants to pay ○ insufficient govt funding	low ability of participants to pay insufficient govt funding	○ donor dependency ○ insufficient govt funding

Appendix 2 Profile of Maintenance Trainers by Institution

Trainers of Maintenance in Technical Colleges and Institutes in Tanzania

		Number of Trainers									
	Institution	MTC			KTC				TCA	RWRI	TEMDO
	Topic / Dept.	ME	ARCH	COMP	ME/ AUTO	CE	EE	COMP			
	Automotive Maintenance & repair				4				1		
	Computer technology				3						
	Computer-Aided-Maintenance	2		-							
	Condition monitoring	1		-							
	Controlling distortion	1		-							
	Electrical power utilisation				3						
	Engine tuning	1		-							
	Fuel systems	1		-							
	Industrial safety	1		-							
	Injection pump faults	1		-							
	Introduction to Maintenance	1		-							
	Introduction to repair technology	1									
	Inventory control	1		-							
	Inventory planning & control										1
	Lubrication systems	1									
	Machine elements & design				2						
	Machine installation										1
	Maintenance				1						
	Maintenance cards	1		-							

	Maintenance cards (practical)	1									
	Maintenance concepts										1
	Maintenance costs										1
	Maintenance costs and equipment										1
	Maintenance Organisation	1		-							
	Maintenance planning & scheduling										1
	Maintenance Planning and Scheduling	1		-							
	Maintenance Procedure	1		-							
	Manufacturing technology				1						
	Plant layout										1
	Plant Maintenance								1		
	Production techniques				1						
	Quality										1
	Quality control	1		-							
	Repair and maintenance of electronic equipment.				3						
	Replacement policy										1
	Road Maintenance				1				3		
	Welding joints	1									
	Work study	1									
	Work study										1
	Workshop administration										1

Appendix 3: Proceedings of a Planning meeting on the study (August 5, 1998)

PROCEEDINGS OF PLANNING OR TECHNICAL MEETING

OF A STUDY ON

THE TRAINING OF MAINTENANCE PERSONNEL IN TANZANIA.

Institute of Technology Management *(TechMa)*

Dar es Salaam
August, 1998

Abbreviations

DIT	Dar es Salaam Institute of Technology
IPC	Investment Promotion Centre
SIDP	Ministry of Science, Technology and Higher Education
MSTHE	Sustainable Industrial Development Programme
TechMa	Institute of Technology Management
TIC	Tanzania Investment Centre
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VETA	Vocational Education and Training Authority

Preface

This report presents a summary of proceedings of planning or technical meeting of a study on The Training of maintenance personnel in Tanzania. The meeting was held in Dar es Salaam (Luther House, along Sokoine Drive) on August 1998.

The meeting was intended to benefit the researchers from inputs made by representatives of stakeholder institutions in the area of study.

In all five representatives from stakeholder institutions attended the meeting. The full list of the participants to the meeting appears in these proceedings as Appendix 1.

The text of the report is organized in four chapters and three appendices.

CHAPTER ONE

OPENING SESSION

Two main functions took place during the opening session of the technical meeting: a welcome address and an outline of the background to the study. This chapter will summarise the contents of the above main functions carried out during the opening session.

1.1 Welcome address

In contrast to other meetings of this nature, there was no formal and written official welcome address read before the participants, nor was an invited Guest of honour for the occasion. Instead, one of the *TechMa*[15] Directors delivered orally a welcome address. But before the welcome address was given, participants were given an opportunity to introduce each other. Appendix 1 provides a summary of the self-introduction made amongst the participants.

In the welcome address, Prof.Mlawa, on behalf of *TechMa*, thanked the participants for having found time to attend the meeting. He described their attendance to the meeting as being extremely inspirational and highly encouraging. He added that their participation in the meeting reflected their commitment to working closely and partnership with *TechMa* on the issues on hand training of maintenance personnel and development. He hoped that deliberations of the meeting would be both productive and fruitful.

Prof. Mlawa further outlined the primary objectives of the meeting. He said the technical meeting had three primary objectives:

(i) To introduce the study on the training of maintenance personnel to the participating members all of whom are representing key stakeholder institutions in the country.

(ii) To exchange ideas and views, amongst the participating members and the institutions they are representing on their involvement on issues of maintenance and development and the related ones.

(iii) To present the instruments designed by *TechMa* to be used for data collection during the field survey of the study.

(iv) To benefit, from comments, views and suggestions, from the participants on the instruments for data collection, for improvement.

(v) To identify avenues for collaboration and team working between *TechMa* on the one hand, and the institutions represented in the technical meeting on issues shared interest e.g. culture of maintenance for development; and technology management and development; and so forth.

In the welcome address Prof. Mlawa also informed the members that the broader objective of the study is to examine the training of maintenance personnel in a number of Eastern Africa countries including Tanzania, Kenya, Zambia and Namibia. This particular study will confine itself on Tanzania, and only later on will the study extend to other countries mentioned above.

[15] A brief of *TechMa* is given in Appendix 2 of these proceedings.

Within the above mentioned broad objective, the Tanzanian chapter of the study has three main objectives:

(i) To develop an inventory (list) of the training institutions in Tanzania which conduct maintenance training.

(ii) To examine the nature of existing maintenance related programmes in Training institutions in the country.

(iii) To develop a list and profile of trainers on maintenance drawn from the institutions studied.

(iv) To describe the strengths and weaknesses relevant for handling maintenance training, of the institution identified in the country.

(v) To develop a database in Tanzania in respect to institutions for training maintenance personnel, trainers of maintenance, maintenance training programmes, inventory of trainers of maintenance programmes based on the countries selected for study. In turn the database will provide a basis for networking amongst the institutions in relation to conducting maintenance-training programmes in the countries studied.

(iv) Based on the findings, the study will propose a set of measures to put in place aimed at improving the training of maintenance staff in the country and other countries in the sub region facing similar problems.

1.2 Background to the study

Prof.Bavu took time to outline the background of the study. He said, it all began with the UN General Assembly launching the concept of the cultural dimension of development. Subsequent to this UNESCO was given the task of developing projects which will take into account the importance of culture to human development. In this sense, there was realization of the relationship between culture and development. Within this broad problem, there has developed, within UNESCO, great concern and interest on the cultural dimension of maintenance or more precisely culture of maintenance for development. It is believed by many, that a positive culture of maintenance is developmental it will facilitate and support a faster rate of development. By the same token a negative culture of maintenance is undevelopmental it will hinder and frustrate a reasonable rate of development of an economy.

The audience was further informed that the African Development Bank (ADB) has expressed interest to support projects on aspects of culture of maintenance for development. He also informed the audience that UNESCO is developing an inter-sectoral and interdisciplinary Umbrella Project on Culture of Maintenance in Africa; and that UNESCO is committed to the development of a Centre for Maintenance in Africa which will be located in Dar es Salaam Tanzania.

Furthermore, Prof.Bavu informed the audience that apart from this study on the training of maintenance personnel -*TechMa* intends to carry out other studies on the subject of culture of maintenance for sustainable development. These anticipated studies would focus on various aspects of the subject such as:

- **Maintenance mindedness at Primary school level**

  To investigate into the extent at which maintenance features in the school curriculum and/or school timetable

- **Maintenance at household level**

  To find out whether planning t the household level incorporates maintenance aspects

- **Maintenance training for adults**

  To examine whether maintenance training focus part and parcel of adult learning/education and/or life style of adults.

- **Sensitization of the general public**

  To demand maintenance to make the general public aware of the maintenance and make them demand and ask for maintenance to be provided for by the relevant bodies and authorities.

- **Cost of non-maintenance**

  To investigate the costs direct and indirect; financial and social etc that a productive enterprise may incur for not maintaining its productive structures.

2.3 Summary

This chapter summarized the proceedings of the opening session as a general background to the other aspects of the technical meeting of the study.

CHAPTER TWO

Instruments for Data Collection

This chapter will first summarize the presentation of the instruments for administering during the field survey for data collection for the study and as prepared by *TechMa*. It will also summarize the views and comments made by the participants to the questionnaire and to the focus of the study generally.

2.1 Presentation of instruments for data collection (or questionnaire)

TechMa underlined the primary objective of the study: to investigate the nature and extent of maintenance training within a selected number of training institutions in the country. It was also stressed that during this phase of the study, the focus is on the supply side of maintenance staff how and what quality of the personnel and the ways they are trained i.e. nature of training. The issues of demand side of the training i.e. issues of the use of maintenance staff after their training (e.g. who employees the trainees and how are they engaged and used in the firms after their training etc) will be handled in a subsequent phase.

Thereafter, Dr.S.Kawambwa a *TechMa* Director - introduced the questionnaire, which was designed for administration during the field survey phase of the study[16]. Dr.Kawambwa informed the participants that the questionnaire was divided into four sections. **Section A** covering a set of questions and issues relating to the Mission and Mandate and activity programmes of the training institutions investigated; **Section B** will cover a set of questions focusing on the kinds and levels of in-house capabilities available within the training institutions, needed and relevant for the efficient carrying out of maintenance training functions. **Section C** contains a set of questions aimed at getting a feel on some of the major achievements made in and by the maintenance training institutions investigated. And finally **section D** is futuristic. It poses a very general and open ended question on future plans the training institutions examined may have.

2.2 Inputs, comments and views made by participants

Based on *TechMa's* presentation of the study and the questionnaire, the participants made a number of interesting and useful comments, observations and contributions. The major ones are briefly summarized in the sub sections that follow.

2.2.1 Importance of the study

All the participants commended *TechMa* for conceiving this project at this opportune time. They identified themselves with the study and recognized the seriousness and magnitude of the problem of the poor or near absence of maintenance in productive structures in the country. They also concurred that the broader impact of poor maintenance is to hold back production and productivity in practically all sectors of production and service delivery in the economy. They all stressed that both competitive performance and sustainable development of the economy now and in the future will depend to a significant extent on efficient maintenance management of productive and service sectors.

They also affirmed the fat that maintenance has both technical (or engineering) as well as social or cultural dimensions. They were thus pleased to note that the study addresses both of these aspects.

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[16] One copy of the questionnaire is appended to these proceedings.

Participants commended UNESCO for supporting the study financially. Dr.Joof, UNESCO Country Representative in Tanzania expressed to the participants, UNESCO Director General's profound interest to the outcome of the project. He emphasized the fact that successful implementation of the study will be a major victory to both *TechMa* and UNESCO. Dr.Joof also expressed the hope that a series of follow up tracer would be emerge from the findings of this study, and that it may be possible then to explore funding from UNESCO for implementing the anticipated tracer studies. Dr.Joof further informed the meeting that UNESCO deep interest and commitment to problems of culture of maintenance for sustainable development in the region, UNESCO Director General has transferred one of their staff (Dr.Insa Issa) from UNESCO office in Harare to their Dar es Salaam office. Dr.Issa will be working very closely with UNESCO Dar office and *TechMa* in developing useful programmes on aspects of culture of maintenance for sustainable development in Tanzania and the region.

The entire meeting was extremely gratified to learn of UNESCO firm and continued commitment to problems of culture of maintenance and sustainable development in Tanzania and in the continent.

2.2.2 Poor stakeholder representation to the meeting

The participants repeatedly underscored the point that instilling a sense of maintenance mindedness and relevant skills and knowledge amongst a society is a mammoth task. It is also a responsibility of many authorities and organs in society not only of a few ministries, departments and training institutions. As such then, the audience expressed the concern that a lot more institutions and organizations, as stakeholders, ought to have been represented to the meeting than what is represented in the meeting.

In response to this observation, TechMa staff responded that this technical or planning meeting was deliberately designed to draw representatives of a few select, yet key, stakeholder groups. However, at an appropriate point in the study execution process (most likely when presenting the draft report) an expanded representation drawn from a much larger stakeholder group would be invited. This is deliberately planned so inorder to facilitate the sharing of experience, knowledge and understanding of problems of culture of maintenance for sustainable development in the country and in Africa.

2.2.3 Different questionnaire for the aspects of the demand side

A participant of the meeting inquired whether a different instrument for data collection will be designed for data collection when executing the follow up study dealing with the demand side of the problem of culture of maintenance for sustainable development in Tanzania.

TechMa officials responded by saying most certainly this will be the case. When dealing with and questions of efficient use of maintenance personnel in productive and infrastructure facilities, a questionnaire specifically designed for this will be designed. That questionnaire will seek to get answers to questions and statements relating to functions and roles that staff are assigned in industry after training; how many there are in a plant work conditions, relationship of the maintenance staff and department with other staff and departments within a plant eg production staff and department; marketing or sales staff and department; general management staff and department; accounts/finance staff and department. And so forth.

2.2.4 Need for Sensitization Programmes on Culture of Maintenance for Sustainable Development

Bearing in mind the limited level of scientific literacy in the country; and the need for broad based knowledge and understanding of maintenance for development, the meeting called for

the urgent need of designing and hosting a series of sensitization programmes in the subject. The objective being to raise the society's understanding and concern for maintenance for development. In turn, this hopefully will raise a society's need and level of appreciation of the importance and care of property and artifacts and consequently to maintenance of equipment, property etc.

TechMa responded positively to this need; and expressed willingness to take on the challenge. *TechMa* also informed the meeting that already it has co-organized, with UNESCO a sensitization workshop on culture of maintenance for sustainable development in Dar es Salaam in March 5-6, 1996. The workshop was extremely successful. *TechMa* will, in the future, organize, with like-minded organizations, similar sensitization workshops.

2.2.5 Logical starting Point for Maintenance Training

Maintenance as an operational activity, to be effective must be ongoing and regular. Within a plant, maintenance to be effective must be carried out at all points in the production process must not be localized at particular points. Likewise, to be effective maintenance training must be continuous and should be carried out at all levels in the education and training system of a society. It must start logically at childhood. The child must be told and taught by his/her parents how to take care of herself, her clothes, to value his/her own property and belongings and those of others and of the family. For these important lessons, teachings etc to be reinforced and enhanced, they will have to be taught again and again in the formal school system B at kindergarten, primary school, secondary school, college level, university level and beyond.

So really the starting point maintenance training is childhood and within the premises of the family B household. Thereafter, it is endless B continues at the kindergarten stage on B indefinitely. And even after on his graduated in maintenance training at one level or other, there is always logic and economic sense for retraining. Only when maintenance is handled this way, will it be engrained as a cultural trait into a society. The skills and empowerments for carrying out maintenance work will be well internalized within practically all individuals in the society. The culture of maintenance will be well imbued within the society. Society will be conscious of the need for maintenance B and will infact demand maintenance work to be carried out as early as the need arises.

2.2.6 Gaps and Inadequacies in the Education and Training System

The committee also raised concern on gaps and inadequacies in the educational and training system as factors contributing to poor mastery of maintenance skills, expertise etc by the trainees. The meeting was reminded of the fact that in the past, it was regular for primary schools to have or student inspection rounds every morning before classes began. In those sessions, teachers checked students of body cleanliness and smartness B checked whether the pupils uniforms were clean and nicely pressed; his/her hair is properly combed/nicely plaited; nailed neatly cut; teeth properly brushed, shoes (if any) well polished etc. In a sense this was maintenance training, instilling a cultural sense for keeping ones body in a good condition etc. Such education/training formed a basis for a subsequent maintenance training/training education at later stages of the formal education system.

In recent years, however, one sees very little, if at all, of these kinds of inspection sessions at primary and secondary school levels. The base for maintenance mindedness is no longer being laid in formal educational institutions these days. This is a gap which members identified and hoped that the relevant authorities will take appropriate steps to redress the situation.

2.2.7 The Need for Team Working in Maintenance Training/Education

The process of building a culture of maintenance to a community (or maintenance training) involves the participation of many actors. These include, inter alia, the household, formal educational institutions, training institutions, industry etc. All these must work together in partnership for the trainees to build up the required types and qualities of maintenance expertise skills etc for productive use. This raises the need for team working amongst all the important stakeholder groups involved in the process of developing maintenance culture broadly and developing maintenance skills and expertise particularly.

3.3 Summary

This chapter has summarized first the main aspects of the context of the questionnaire of the study as was introduced to the meeting; and secondly the main comments and contributions of the participants to the questionnaire and the study in general.

CHAPTER THREE

CLOSING SESSION

Introduction

This final chapter summarizes the proceedings of the closing session of the technical or planning meeting of the study. It winds up with overall impression of both the meeting and of the proposed study.

3.1 Closing session

On behalf of *TechMa*, Prof.Mlawa once gain thanked the participants for having found time to attend the meeting. He also expressed *TechMa's* gratitude for the participants comments, views, suggestions etc on the study in general and on the questionnaire in particular. He assured the participants of *TechMa's* commitment to take on board all the useful suggestions put forward in order to improve the instruments and make the study a success. He finally expressed the hope that it will be possible for *TechMa* to work together, in partnership, with them as the study progresses, and also in similar undertakings. On behalf of *TechMa* Prof.Mlawa wished the participants all the very best.

3.2 Overall Assessment of the Meeting

The meeting was extremely successful and productive. It had put together minds of key stakeholder groups who have a stake in maintenance training for improved performance and sustainable development. The contributions by the stakeholders (in the form of suggestions, criticisms, views etc) on the questionnaire and study proposal were all on target. Based on these contributions, we have improved on the questionnaire and greatly sharpened the objectives and focus of the study.

Perhaps more important for us is that we have, through this meeting have established a solid foundation for a participatory approach bringing in as it were interested stakeholder groups in the processes of both designing and executing an applied or action B oriented study such as this one. And there is a commitment for continued productive interaction, partnering and networking amongst the stakeholder groups during the course of implementing this study. We will continue with this practice in all the policy B related studies we will carry out. It promises to be a fruitful and productive strategy for carrying out policy studies in this and related studies now and for the future.

4.3 Summary

This chapter has summarized the closing session of the technical meeting. It has also underlined the potential utility of a participatory approach in carrying out action oriented studies of this nature for getting the study results into application on the ground.

Appendix 1: List of Participants

	Name	Title	Organisation	Address
1	Mrs. E N Mnzava	Secretary General	UNESCO National Commission	P.O. Box 20384. Dar es salaam.
2.	Mr. S R Sijaona	Liaison Officer	UNESCO National Commission	P.O. Box 20384. Dar es salaam.
3.	T Mteleka	Dr./Director General	Division of Science and Technology. Ministry of Science, Technology and Higher Education.	P.O. Box 2645. Dar es salaam.
4.	Dr. M B Joof	UNESCO Rep.	UNESCO Field Office. Dar es salaam.	P.O. Box 31473. Dar es salaam.
5.	Mr. S H Mwiry	Director	Vocational Training. Ministry of Science, Technology and Higher Education.	P.O. Box 2645. Dar es salaam. Tel. (051) 11070.
6.	Mr. John N L Aligawesa	Representing Principal	Dar es salaam Institute of Technology.	P.O. Box 2958 Dar es salaam. Tel. (051) 152 032
7.	I K Bavu	Prof./ Director	INSTITUTE OF TECHNOLOGY MANAGEMENT (*TechMa*)	P.O.Box 35000. Dar es salaam.
8.	H M Mlawa	Prof./ Director	INSTITUTE OF TECHNOLOGY MANAGEMENT (*TechMa*)	P.O.Box 35000. Dar es salaam.
9.	S J M Kawambwa	Maintenance Expert	INSTITUTE OF TECHNOLOGY MANAGEMENT (*TechMa*)	P.O.Box 35000. Dar es salaam.
10.	E.N. Ngowi	Director of Training	VETA	P.O. Box Dar es Salaam Tel. 863407
11.	B. J. Humplick	Freelance Consultant		P.O. box 3614 Dar es Salaam
12.	W. Bavu	Manager	Luther House	P.O. Box Dar es Salaam

Questionnaire: *Training Institutions*

Date of interview:

Interviewer(s):

Respondent: Name .....

Title .....

Name of Institution:

Address/Location:

Tel.

Fax:

Ownership:

- ☐ Private
- ☐ Parastatal
- ☐ Government Department
- ☐ Other: Specify .....

Mission/Mandate of Training Institution:

Questions on **Institutions for training maintenance staff**

A ***Mission and Activity Programmes***

1. What is the mission/mandate of your Institution?

.....
.....
.....

2. Do you consider execution of maintenance activities a major objective of your instiution?

.....
.....
.....

3. *It is suggested that maintenance has a cultural dimension. Do you prescribe to this idea?*

☐ *Yes*
☐ *No*

If YES what are the cultural elements related to maintenance?

.....
.....
.....

B ***In-house Capabilities***

4. What would you consider to be the major strengths of the maintenance course that your institution is offering?

.....
.....
.....

5. What would you consider to be the main weaknesses of the maintenance course your institution is offering?

.....
.....
.....

6. How frequently is training conducted?

.....
.....
.....

7. How do you reach out to your target group?

.....
.....
.....

8. How do you promote the maintenance course in particular and all training activities in general?

.....

.....

.....

9. What is the average training cost per participant?

.....

.....

10. In your opinion, is the maintenance training programme in your institution sustainable?

Yes ☐ ☐ *No*

Please explain:

.....

.....

.....

What are your sources of funding for the Maintenance training programmes?

.....

.....

.....

What in your opinion are the major problems (bottlenecks) facing your Institution with regard to training in general and training of maintenance personnel in particular.

- ☐ Finance
- ☐ Staff number
- ☐ Physical facilities
- ☐ General administration
- ☐ Staff remuneration
- ☐ Staff motivation
- ☐ Links with industry
- ☐ Appropriate entry qualifications
- ☐ Curriculum development
- ☐ Information resources (e.g. books, journals etc)
- ☐ Maintenance experience of trainers
- ☐ Other (specify): .....

11. *Which other Training Institutions do you cooperate with in the area of maintenance training?*

.....

.....

.....

In which ways do you collaborate?

.....

.....

.....

12. Maintenance courses for Engineers and Technicians

Please list down in the Table below, the courses that your Institute are offering

S/N	COURSE TITLE	DURATION (e.g. 3t./wk x 10 wks)	MAIN TOPICS[17]	TARGET GROUP	TRAINING CAPACITY[18]	FEES / Tshs.[19]	% THEORY[20]	% PRACTICALS	REMARKS

[17] List topics on the back of this sheet
[18] students trained per year
[19] total programme fees
[20] estimated proportion of theory/practicals in the training

14. Coverage of maintenance relevant topics

Please indicate in the Table below, the extent to which each listed topic is covered by the maintenance programme(s) offered by your Institution.

	Topic	**Level of Coverage of topic in the course** (Please circle appropriate level)				
		Low				***High***
		1	2	3	4	5
1	Maintenance Organisation					
2	Maintenance Planning					
3	Project management					
4	Maintenance control					
5	Industrial Safety					
6	Applied probability and statistics in maintenance					
7	Operations Research Methods in maintenance.					
8	Condition monitoring techniques					
9	Engineering economics methods in maintenance					
10	Simulation techniques applied to maintenance.					
11	Design of Machine elements					
12	Basic Computer skills in maintenance.					
13	Costing of maintenance.					
14	Supervisory skills for maintenance.					
15	Maintenance techniques for buildings.					
16	Maintenance of water systems.					
17	Maintenance of Roads.					
18	Environmental preservation and management.					
19	Construction Management skills.					
20	Repair and maintenance of electronic equipment.					
21	Repair and maintenance of electrical equipment					
22	Repair and maintenance of mechanical plants (boilers, machine tools, etc)					
23	Repair and maintenance of process and chemical plants.					
24	Socio-cultural environment of maintenance					
25	Cleanliness as an aspect of maintenance					
26	Relation of Maint. Dept. with Production – structural and functional.					
27	Others: Specify					

15. How do you determine the market needs of your maintenance training programmes?

16. Profile of Maintenance Trainers

Please provide tata on staff involved in your maintenance training programmes as per Table below.

S/N	NAME (Title, First, Middle, Surname)	Gender M/F	1st DEGREE (FIELD)	MASTERS DEGREE (FIELD)	PhD (SUBJECT)	OTHER QUALIFICATIONS (e.g. HND, etc)	PRACTICAL EXPERIENCE IN MAINT. (Years)	MAINTENANCE TOPIC(S) HE/SHE TEACHES

17. Training facilities with relevance to maintenance training:

Please enter in the Table below all the major facilities that exist in your institution that are being used or could be used for maintenance training.

Please tick	*Facility*	**Quantity**	**Capacity**	**Adequacy for training (Yes/No)**
	Mechanical Engineering:			
	Design facilities (e.g. CAD)			
	Production Machine shops/ laboratory			
	Materials testing			
	Engines, Turbomachinery and Energy Technology			
	Air conditioning and refrigeration			
	Industrial and Maintenance Engineering laboratory			
	Hydraulics and pneumatics			
	Other			
	.....			
	Civil Engineering:			
	Soil and Foundation engineering			
	Building materials			
	Water resources			
	Structural design			
	Structural analysis			
	Hydraulic engineering laboratory			
	Transport and highway laboratory			
	Surveying			
	Other			
	.....			

	Chemical and Process Engineering:			
	Design of plants			
	Process Technology			
	Measurement and control			
	Chemical analysis			
	Thermofluids			
	Chemical reactions engineering			
	Mass and energy balance			
	Other			
	.....			
	Electrical and Electronic Engineering			
	Computer facilities			
	Electronics laboratory			
	Electrical machinery			
	High voltage systems			
	Telecommunications			
	Structural analysis			
	Measurement and control			
	Other (specify):			
	.....			
	.....			
	.....			

C *Achievements made*

Please provide the following documents if available:

- ☐ The most recent tracer study reports by your institution
- ☐ Annual reports
- ☐ Monitoring and Evaluation reports
- ☐ Strategic, or similar plans.

18. Data on graduates trained in maintenance over the last 5 years:

Graduates of Maintenance courses

Year / Course	*1993*	*1994*	*1995*	*1996*	**1997**

19. Who have been the major employers of your graduates over the last 5 years?

.....

.....

Do your graduates come back for upgrading courses in Maintenance?

☐ *Yes*

☐ *No*

If NOT, where have your trainees graduated from?

.....

.....

Profile of Trainees

(a) What are the entrance qualifications of your trainees?

		Please tick as appropriate			
S/N	**Course**	Std VII	Form IV	Form VI	College/Univ. Graduate

(b) Is work experience a required entrance qualification?

☐ Yes
☐ No

D *Future Plans*

20. What are your future (maintenance related) training plans?

.....

.....

Appendix 4: Proceedings of Project Review Workshop

PROCEEDINGS OF A WORKSHOP ON

INSTITUTIONS FOR TRAINING MAINTENANCE STAFF: KENYA, NAMIBIA, TANZANIA, UGANDA AND ZIMBABWE

Held at

DAR ES SALAAM

March 5, 1999

Institute of Technology Management (*TechMa*), Luther House, Sokoine Drive, P O Box 35000, Dar es Salaam, Tanzania

PREFACE

This is a proceedings report. It summaries the main issues raised in a one day meeting on the training of maintenance personnel in Tanzania which was held in Dar es salaam. (March 5, 1999). The text of the proceedings is organised in six items with an Appendix which gives a list of the workshop participants.

Table of Contents

INTRODUCTION

A Word of Welcome from Professor H M Mlawa

The meeting was called to order at 9.30 a.m. after self-introduction by participants, Professor I K Bavu called on Professor H M Mlawa to give a word of welcome.

Professor Mlawa showed appreciation and thanks to the participants for the sacrifice they made by coming to share their respective experiences in maintenance and its problems. *TechMa* was happy to be in such a young area as the culture of maintenance. *TechMa* hoped to gain from the participants.

There are many programmes such as poverty alleviation, literacy campaigns, environment and so on, which emphasize infrastructure. Yet the question of how that infrastructure could be maintained for sustainable development is rarely addressed.

To *TechMa* maintenance is crucial if the infrastructure is to last. This includes physical maintenance as well as a culture of maintenance.

Item I: History and Objectives of the Maintenance Project

- Professor I K Bavu

Professor Bavu used the opportunity to thank UNESCO for taking up the problem of maintenance and expressed hope that other partners in development would join in.

Culture of Maintenance as a concept is found in the vocabulary of many countries. In 1971 UNIDO coined the concept of "Maintenance Mindedness". In the 1980s DANIDA carried out an extensive rehabilitation programme for schools in Tanzania. It was however in the 1990 - 1 period that UNESCO started using the concept and officially adopting it in 1995.

Culture of Maintenance means appreciation or commitment to caring for things we use, making sure they continue to function efficiently. This entails technical know-how, a budget and constant maintenance. So it is essentially a way of life, hence the element of culture, which should not be limited to traditional activities such as, dances and dress.

Lack of a culture of maintenance is a global problem affecting a majority of developing countries, more especially in Africa. Many of these countries have already taken remedial steps. Unfortunately African countries do not feature among them. A European Union workshop in 1991 showed that of the equipment worth US $ 5 billion, between 40 - 70 percent did not meet the five year expected life time. This is an example of poor prioritization. In consequence there are equipment worth US $ 7 billion in Africa lying idle for lack of spares or for lack of maintenance.

The same year (1995), the Director General of UNESCO proposed the setting up of a Maintenance Centre in Dar es Salaam. From this was to be built a Maintenance Network beginning with Kenya, Uganda, Tanzania, Namibia and Zimbabwe. UNESCO is in the process of setting up this centre in Dar es Salaam from 1998 with the posting of an Advisor for Science and Technology to the Dar es salaam field office.

The purpose of this Tanzania study was to assess the current potential of institutions with a view to improving the skills taught to technicians so as to upgrade maintenance capacity as well as to determine the extent the teaching or training addressed the aesthetics and care for property.

Item 2: Design of the Tanzania Study

- Dr E A Mjema

Formation of the research team took into account the multidimensional nature of maintenance. Its composition therefore had to be interdisciplinary. Of the five members two, Professor I K Bavu and Professor H M Mlawa, were social scientists while Dr Kawambwa, Dr Kundi and Dr Mjema were engineers.

Institutions visited included Dar es Salaam Regional Vocational Training and Service Centre, Centre for Agricultural Mechanisation and Rural Technology, Tanzania Engineering Manufacturing and Design Organisation, Karume Technical College, Mbeya Technical College, Technical College Arusha, Dar es Salaam Institute of Technology, Sokoine University of Agriculture and Faculty of Engineering of the University of Dar es Salaam.

When visiting these institutions the researchers sought data on maintenance curricula and programmes, training aids and facilities and finally made an assessment of the state of the art in maintenance.

Data collection instruments were in a form of questionnaire. It sought to establish the mission and activities of the institutions, in-house capabilities, achievements and future expectations of the institution. Data was collected through administration of the questionnaire as well as through field visits to the institutions. A meeting was held with the Ministry for Science Technology and Higher Education together with UNESCO and National Commission officials at the end of the visits to review a zero draft of the report.

Item 3: Research Findings

- Dr B A T Kundi

The research has revealed that most of the Institutions conducted short courses on maintenance lasting up to several weeks. Recipients are operatives at the plant level. Universities offer more long-term maintenance training. Also maintenance training is integrated into the degree programmes. However no institution offers exclusive degree programmes on maintenance although technical colleges offer diplomas.

Most institutions show an over capacity of trainers in relation to the intake of trainees. On the other hand equipment and literature for training tended to be inadequate.

Curricula were found to concentrate on engines and machines with little attention on electrical appliances and micro-processors. Curricula have been static and out of touch with the practical needs of users especially in industry.

Most of the training is through lectures with practicals playing a secondary role. Also most trainees were beginners. This approach has the effect of denying trainers an opportunity for experimentation. Involvement of operatives in industries as trainees could have brought in the benefits of their practical experience.

There is a general lack of resources allocated for maintenance training. Most of the funds come from donors. This is a reflection of the little importance attached to maintenance in society in general.

Item 4: Directions for Future Research

- Professor H M Mlawa

There are two main areas that need further research. These are the demand side of maintenance and studies on non-maintenance. So far studies have emphasised the supply side of maintenance. This is due to lack of resources. However there is need to identify who needs maintenance staff and how do maintenance personnel relate to people in the institution where they work. It is also necessary to make a comparative analysis of maintenance issues according to sectors and between countries. So far maintenance is taken as an exclusively technological issue. An interdisciplinary approach would be more effective. Equally important is a course for non-maintenance personnel in industry, the government and other relevant sectors. This could cater for personnel like Managers, Finance personnel, Administrators and the like.

Non maintenance and its consequences are rarely assessed properly. Non maintenance could lead to material loss and inefficiency. There are also social costs such as death as for instance an ambulance or a fire truck that does not function. Many electrocutions have resulted from faulty electrical appliances. Poor education standards are partly caused by the break down of infrastructure of schools.

Two other minor areas worthy of attention are tracer-studies to tighten study concepts and sensitisation of the masses, which is a cultural category.

Item 5: Reactions from Participants

Reactions can be put under three categories. These are discussions on the conceptualisation of maintenance; causes of lack of maintenance; and possible solutions.

5.1 Maintenance as a Concept

It was pointed out that there are stages of maintenance corresponding to the extent of damage involved. The initial point is when the entity in question is functioning according to expectations. At this stage maintenance entails preserving the entity as it is. This was termed "preservative maintenance". It involves all users in the community and so is a cultural category. The motto is "leave me clean and I will not say what I saw". Members of the community learn to be individually responsible for communal property.

After use for a period of time there is bound to be wear and tear. Members of the community are responsible for reporting to the relevant authorities any signs of malfunction. This stage is "service

maintenance" and though too technical for rectification by the ordinary members of the community, it is still small enough to be put right by an artisan or technician so it is techno-cultural. The motto is "a stitch in time saves nine".

There comes a point where problems need more than servicing. Whole parts may have to be replaced. This was termed "renovative maintenance". It is largely technical rather than cultural and involves such experts as engineers. Here the motto is "shed your skin and be young".

5.2 Causes of Poor Maintenance

Six basic causes of poor maintenance were identified. Top on the list was culture. It was noted that modern artefacts have *not yet been integrated into the culture* of the majority of the people. Misuse may therefore result out of ignorance. At another level people feel they are not individually responsible for what belongs to society which is viewed as an entity separate from the individuals. This is lack of sense of responsibility.

Sometimes poor maintenance is not just carelessness but deliberate. This is often as a sign protest. During the struggle against colonialism destruction of public property was considered appropriate. Even personal hygiene suffered because such things as combing hair and brushing shoes were considered colonialist. Today untidy dressing is fashionable. This rebelliousness often touches public property.

A second cause is *lack of trained people* to carry out maintenance (at service and renovative stages). Curricula have only a small portion devoted to maintenance. When the few that get trained graduate, they discover to their dismay that what they learned bears little relevance to the practical jobs. They may have been trained on state-of-the-art technology while what is in general use is still some old technology. Under-utilisation also occurs at the training level where trainers handle fewer trainees than would be optimal.

Thirdly there may arise an occasion when *maintenance is more expensive* than a new item. This is especially true at the renovative maintenance stage and mainly concerns such durable consumer items as computers and vehicles. The reason being that newer models tend to be cheaper while spares for older models get increasingly hard to find with time.

Fourthly there is *lack of prioritisation;* meaning budgets do often exclude maintenance costs. This is the outcome of misconceptions by management. There is therefore a discrepancy between

perceptions of management and those of the technical experts. Such things as maintenance are not taken into account.

Sometimes the difference in perception results from a deliberate attempt to "*pass the buck*". The various officials shun responsibility hoping someone else will take them. This forms the fifth reason. Use of machinery or a structure continues while nobody assesses its state of function till it grinds to a halt.

One reason that proved to be a bone of contention among participants was *poverty*. Some participants held the view that poverty of the developing countries means they can not make maintenance a priority, as there are many more pressing matters. An example was given of factories kept running by improvised parts for lack of funds to buy genuine ones.

A contrary view held that misuse was more to blame than poverty. For example rooms in the halls of residence at a University which were designed to accommodate two students each, often ends up with eight of them. Worse still these students carry sacks of food up those buildings and cook in the rooms. Another instance is the suburbs bequeathed by the colonialists, which are used for rearing livestock. These residents running the place are anything but poor.

5.3 Solutions

It was suggested that the provisions of trained maintenance technicians or engineers was a major foundation stone for the building of a maintenance culture, by itself was not sufficient to build a culture of maintenance. More needs to be done in order for a strong culture of maintenance to develop. The question is how much more? or how much is the contribution of training of technicians/engineers to the development of maintenance culture? The answer to this question has to feature in the report of the study.

Suggested solutions followed close at the heels of perceived causes. One was that a new culture of maintenance be inculcated in society. People must begin to take responsibility of public property. They should be made to realise how much their lives depended on such property.

Where damage results more from ignorance than from irresponsibility, it was suggested that the level of technical know-how in the general populace be increased. Ordinary people should at least be in a position to detect faults in time and notify the relevant authorities.

There was a suggestion that standards of function be set for institutions. Those found to operate below such standards due to lack of maintenance should be grounded. This would be feasible where there is competition and therefore alternatives.

Even properly run institutions could be in trouble because of technological revolution. There is need to keep abreast with changes and to modify accordingly. Such modification becomes smoother if there is constant liaison between management and technical experts. There will then always be a budget for maintenance and for modifications.

In institutions of learning curricula need redesigning to include maintenance. This should be the case with all institutions irrespective of whether or not they are technical. To this end *TechMa* has on the drawing board a plan for the teaching of maintenance from primary to tertiary education.

Item 6: Concluding Remarks

- Professor I K Bavu

The Maintenance Centre being established in Dar es Salaam, Tanzania, will have a network in Eastern and Southern Africa. Participants at the conference are to serve as Focal Points in their respective countries.

In order to collect data relevant to the Mainte-Net the Focal Points are to administer a questionnaire consisting of the most pertinent and relevant questions from the questionnaire used in the present study, which then may be adopted in accordance with the needs of their respective countries. Any alterations in the questionnaire should be relayed to *TechMa* by E-mail. Thereafter funds for the survey research are to be remitted to the Focal Points.

Information to be gathered by Focal Points should include institutions for training in specific sectors, production of specific equipment and maintenance training institutions. They should identify where there are practical needs as for instance road maintenance in Namibia where the Faculty of Science of the University of Namibia was for eighteen months in control of the project in order to train maintenance staff. Areas should be identified where trainees may practice their skills.

TechMa will make use of University networks as well reports of research by other institutions. To that end *TechMa* is to make use of the report of VETA.

Finally *TechMa* intends to be an inclusive institution. For this reason *TechMa* will extend its researches and services to the private sector as well. This is important at this time when much of the economy is in the hands of the private sector.

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