

TVET Centre for Medical Equipment Technology: Maintenance Training Repair Services and Operation

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Abstract

This conceptual TVET project, envisioned the establishment of TVET centre which would focused on providing middle level TVET programme on highly demanded subject, i.e. Medical Equipment technology (Medical equipment maintenance, repairs, operations, training and services) with a capacity of providing repair and maintenance for more than 2000 assorted medical equipment, and further expand its programme on demand base. The project aim is to create job opportunities for 1150 persons in a period of five (5) years, at an average of 230 students per annum to be train as medical equipment technicians. Maintenance and repairs of medical equipment requires a wide range of technical abilities, and the costs and time required to train a technician increase markedly with the level of skill that has to be attained. The lack of middle level manpower, for instance, was found to be bottleneck for development, and as one of the measures to alleviate this problem, technical and vocational training programs have been created in a large number of countries from 1970 onwards. Experience in many developing countries in Africa, particularly Ghana, has revealed that training of technicians to a high level of skills is very expensive. Therefore, the approach for the training of technicians is to do front- line maintenance, for medical equipment in health facilities and delivers benefits to a larger population, supporting primary health care, by servicing large volume of essential medical equipment in a widely distributed health facilities in the capital city and other parts of regional and district administrations. The envisioned Centre therefore, includes provision of services like maintenance training, and repair of medical equipment, focusing on building sustainable technical capacity, implementing transparent & pragmatic systems, while focusing on the preventative care and safe usage of medical equipment.

Keywords: Equipment, Microplate, Spectrum

1.0. Introduction.

1.1. Medical Equipment

The term 'medical equipment' can be interpreted as including a wide range of instruments, equipment, machinery or apparatus used for medical and para- medical purposes. Brown et al. (1986) describe medical equipment simply as being "the equipment which may be found in hospitals, medical research and teaching institutions". This definition includes the entire range of mechanical, electrical and electronic devices used, directly or indirectly, for the delivery of health care. A more selective definition can be found in the relevant Health Equipment Information (HEI) publication of the Medical Devices Agency (MDA) of the Department of Health in London, which states that the term medical equipment comprises: Any device, instrument, apparatus, implement, material substance, or other article (used singly or in combination), together with any accessory thereto, which is intended by the manufacturer for (a) diagnosis, prevention, monitoring, treatment or alleviation of human disease or injury, or (b) investigation or modification of human anatomy or of human physiological process; which does not achieve its principal intended action by pharmaceutical means, but which may be assisted in its functioning by such means (Medical Devices Agency: Health Equipment Information, Issue 98:28).

1.2. Service Description & Application

The maintenance of medical equipment requires a wide range of technical abilities, and the costs and time required to train a technician increase markedly with the level of skill that has to be attained. Experience in many developing countries has revealed that training of technicians to a high level of skills is very expensive. Therefore, the approach for the training of technicians, to do front-line maintenance, for medical equipment in health facilities requires less time, costs, and delivers benefits to a larger population, supporting primary health care, by servicing large volume of essential medical equipment in widely distributed health facilities in the capital city and other part of regional and district administrations medical equipment maintenance and operation training service, therefore, includes provision of services like training, maintenance and repair of medical equipment, focusing on building sustainable technical capacity, implementing transparent & pragmatic systems, while focusing on the preventative care and safe usage of medical equipment.

1.3. Service Supply and Present Demand

There are two aspects to the services supply surrounding medical equipment usage and handling. In countries

with highly systematized and diversified health care services provision, this service is known as ‘Biomedical Engineering,’ and consists in standardization of diagnostic and therapeutic equipment, installation of equipment and apparatus, carrying out preventive and corrective maintenance on equipment, provision of in-service, hands-on-training to equipment operators, and investigate device related incidents. In short, for countries like Ghana, the service is the integration of foreign expertise and technology with local human resources. Apart from trainings provided at Radiology Departments of medical faculties of university of Ghana, Legon, no worthwhile training is provided regarding medical equipment operations at medium level in the country. There are at present close to 3217 Healthcare facilities (GHS) and 45 medical equipment importers and distributors (Business Ghana Magazine, 2011) all over the country. Tens of millions of Ghana Cedi worth of medical equipment and apparatus are being imported every year. Disregarding heavy and very expensive equipment like CT Scans, MRI, SPECT, and LINAC etc for a moment, sample types of Health facility in terms of levels and ownerships (Table.1.2a and 1.2b).

Health Facilities by Ownership

Levels	Number
Facility	-
Government	1607
Private	1284
CHAG	227
Islamic	18
Quasi- Govt	91
TOTAL	3227

Table.1.2.b Healthcare Facilities in Ghana by

Healthcare Facility	Number
Health centers & Clinics	2090
Districts Hospital	343
Christian Health Ass.Ghana	379
Maternity Homes	389
Polyclinics	011
Psychiatrics	003
Teaching Hospitals	003
Regional Hospitals	009
TOTAL	3227

public and private Healthcare institutions in Ghana.

Goals & Objectives

- (i) To establish TVET Centre for Medical Equipment Technology The objective is to develop a partnership program Maintenance Training, Repair, Services and Operation between industry, academia, and healthcare sectors.
- (ii) Develop a comprehensive and coherent framework for analysis, with the objective of contributing to the development of policies and strategies, concerned with the management of medical equipment in

PROJECT REQUIREMENT & ACTIVITIES

2.0. Materials and Inputs

2.1. Materials

The main materials and inputs required for the provision of medical equipment maintenance and operation-training services are indicated in Table 2.0

Table.2.0. Materials Required

Types of material	Unit of Measure
Design and publication of Training manuals	
Text Books (Assorted types)	
Audio visual training kits	
Stationery materials	
Lubricating oils	litres
Chemicals, (Assorted types)	
Soldering leads	kg
Insulating taps, (Assorted)	Roll
Dry cell, assorted	Pck
Electronic components and parts (Assorted)	
Alkaline batteries, Lump sum	Pct
Welding electrodes	Pct
Carbides	Kg
Bottled Oxygen	Kg
Refrigerant	Kg
Miscellaneous Items	

2.2. Technology and Engineering

2.2.1. Technology

The medical equipment maintenance and operation training services would be rendered to various hospitals,

clinics, diagnostic laboratories, bio-medical research centers and other related institutions utilizing medical equipment. The services would be provided both at the service center and at the client's site, as required. The service provision would be basically categorized as follows:

(I) Full-Fledged and Packaged Consultancy Service:

➤ Procurement of Medical equipment:

Initial assessment of customer's budget, requirements and needs to help determine how customer can get the best value for the allocated money;

Based on the specifications and the standards set out by concerned governmental bodies, the envisioned center will participate on the pre and post tendering activities.

➤ Acquisition and translation of manuals and other vital medical documents/ materials;

➤ Developing and implementing procedures and rules designed to better care for the medical equipment, create accountability, clarity and transparency in the care and usage of medical equipment; implement a plan to prevent unauthorized repair and usage.

➤ Installation, testing and commissioning: Handling of erection or erection supervision activities (Installation, testing, commissioning and operation, and safety training), as required.

(II) Maintenance contract for scheduled and unscheduled maintenance:

➤ Comprehensive inventory including: Development of detailed historical maintenance records which show history, current status, location, responsible staff member for oversight, scheduled (Preventive) maintenance needs, online and updated supplier contact information, etc.

➤ Proper cleaning, calibration and other regular scheduled maintenance work;

➤ Critical / emergency equipment response program (on-call service including emergency response procedures);

➤ Equipment repair; if an extremely specialized and sophisticated piece of equipment, if it cannot be handled by local technicians.

➤ Quality assurance / quality control plan customized for a hospital or clinic;

➤ Work order system: request which will be acted upon in under 24 hours including an urgency criteria; etc

III. Training

In addition to the above-mentioned services, the envisioned center would also provide a general biomedical maintenance technician training for the assorted types and sizes of medical equipment under consideration. The minimum requirement of entry level would be SSSCE & WASSCE, and completion of four (4) years Technical Education. Tailor-made sessions will also be provided to various institutions upon special request. The training course generally would consist of lectures and practical sessions on the following topics:

➤ Medical equipment management systems:

➤ Human Physiology and Anatomy

➤ Healthcare Technology Management

➤ Technical drawing

➤ Electronics and electro- techniques

➤ Mechanical services (hospital plant)

➤ Medical Equipment (Assorted)

➤ Hospital fieldwork

2.3.0. Engineering

2.3.1. Machinery and Equipment

The list of machinery, equipment and other facilities required for the provision of medical equipment maintenance and operation training services is shown below (see Table 2.3.1).

Table 2.3.1. Machinery, Equipment & Tools Requirement

Description	Unit of Measure
Laboratory Equipment, assorted	Lot
Mechanical work bench with vice	set
Electrical/electronic work bench with	
Regulated AC and DC power supply out let's	set
Vacuum cleaners and accessories (Assorted)	set
Mobile diesel generator with canopy	
attachment and control system 11KW	
Mobile grinding machine with accessories	set
Mobile drilling machine with accessories	set
Mobile arc welding transformer	set
Mobile gas welding machine	set
Mechanic tool kit with metallic box	set
Electrical/electronic measuring instruments	set
Retractable aluminum ladder (12m)	pcs
Technical drawing kit	Lot
Plumber tool kit with metallic box	set
Refrigerator maintenance and repair kit	set
Soldering gun	set
Lead sucker	Pcs
Used medical equipment, assorted	
types and size (For teaching purpose)	Lump sum

Table.2.3.2 Manpower Requirement

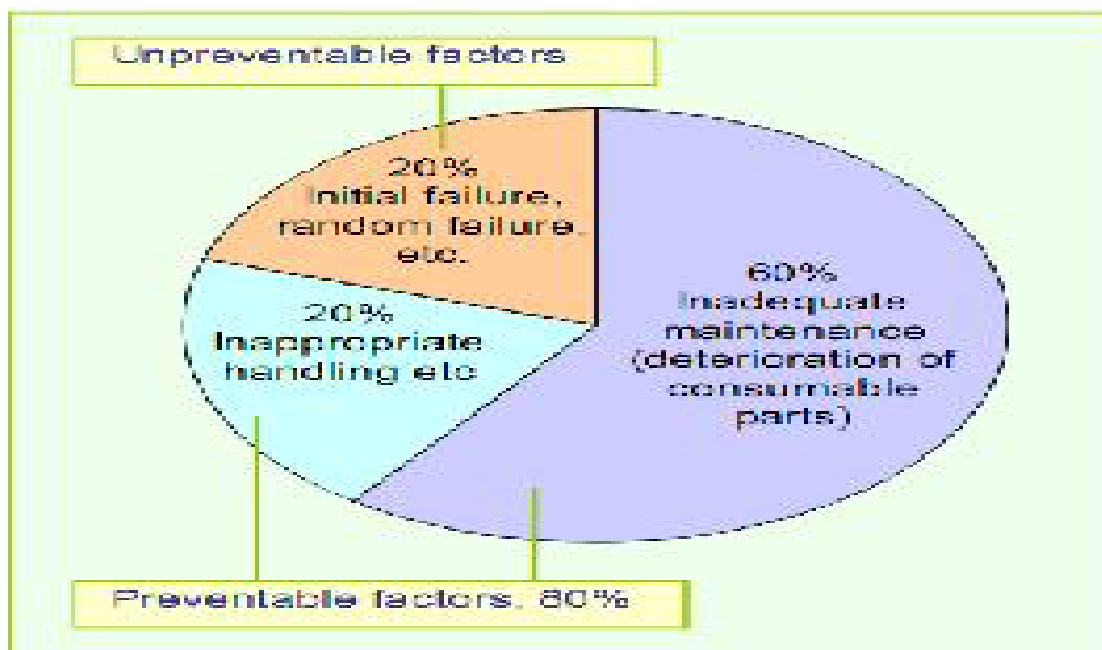
Description	Required Number
Instructors	8
Medical equipment experts (Medical Physicist)	2
Snr Technicians	4
Jnr. Technicians	6
TOTAL	20

Instructors and Technicians need to get local tailor made training and attachment training at similar centers at home or abroad. In the absence of specialized Training Centres or in addition to them, the development of basic skills, applicable to medical equipment maintenance training repairs and services, can to some extent be provided by the national education system. In this way, the most relevant training can be given. In bilateral aid programs, donor countries often provide modern health facilities and sophisticated equipment to developing countries like Ghana. This is an excellent opportunity to request advanced technical and medical equipment management training for in-house staff.

3.0. Expected Project Outcome

3.1. Results

According to statistics (Shoichi Shimizu, JICA Expert on Medical Equipment Management) about 80% of all medical equipment failure cases are caused by preventable factors (Figure 3.1). For instance, failures due to inadequate maintenance account for about 60% of all the medical equipment failure cases. In this case, most failures arise from deterioration of accessories and consumable components. The deterioration time of the accessories and consumable components can, however, be predicted by carrying out maintenance and inspection. Therefore, 60% of all these failures can be prevented by replacing such 'consumable parts' on a regular basis, or replacing them immediately when the equipment becomes defective. These are not real breakdowns of the equipment. In addition to this, failures due to inappropriate handling, environmental stress and wear-out account for about 20% of all the failure cases. Most of these can also be prevented by carrying out appropriate measures based on equipment maintenance system. It can be said that 80



of medical equipment failures are, therefore, preventable. The main focus of the centre is to establish a partnership program between industry, academia, and healthcare sectors. This would comprise a mixture of academic and practical training aimed to equip students for a very wide range of medical equipment maintenance training careers. The centre would establish varied modules to provide in-depth study of a wide range of medical equipment training, with specialization according to interests and future career intentions, according to causes. (Shoichi Shimizu, JICA Expert on Medical Equipment Management) Medical equipment maintenance and operation training service, therefore, may include provision of services like training, maintenance and repair of medical equipment, focusing on building sustainable technical capacity, implementing transparent & pragmatic systems, while focusing on the preventative care and safe usage of medical equipment.

Figure.3.1. Medical equipment failures
Table. 3.1. Classification of Medical Equipment

Radiological	Laboratory	Dental	Surgical
X-ray, CT scans	Microplate Reader	Oil-tree compressor	Poison locker,
Fluoroscopy	Microplate Washer	Dental Instrument Set	Electrosurgical Unit
Ultra Sound,	PH Meter, Balances	Table top autoclave	mattress Operation
MRI, PET,	Water Bath, Biological	Ultrasonic scaler,	Dental unit- Anesthesia Cryogen
SPECT etc	Safety cabinet, centrifuge mounted X-ray machine		Equipment,
Diathermy			
	Water Distiller, Dispenser Vibrator Electric hotplate		operating Light,
	Spectrophotometer,	Plaster mould trimmer	Halothane Vaporizer

Table. 3.1. Shows classification of medical equipment in terms of usage at the Healthcare centres of the country. This gives an indication of variety of expertise required to be trained to handle and maintained the medical equipment maintenance training. The project would require some years to penetrate into the market and capture a significant share. It must start providing services at 75% and 90% of its rated capacity in the first and second year of service provision, respectively. Full service provision shall be attained in the third year and then after. The service operation has to be given for one shift of eight hours per day.

4.0. International Medical Equipment Industry Survey

The international medical equipment industry is extremely diverse. The spectrum of available medical equipment ranges from the most elementary mechanical apparatus, such as the hand operated table-top centrifuge, to the most sophisticated diagnostic and therapeutic equipment, such as computer tomography. It is estimated that the range of medical equipment incorporates approximately 6,000 generic entities and an estimated 750,000 or more brands and models, ranging from simple articles to very complex systems. These devices are produced by an estimated 12,000 manufacturer's world-wide (World Bank, 1993:138). Today, there are more than 10,000 types of medical equipment available in the Ghanaian Hospitals and market. The selection of appropriate medical equipment always depends on local, regional or national requirements; factors to consider include the type of health facility where the equipment are to be used, the health work force available and the

burden of disease experienced in the specific catchment area. It is therefore impossible to make a list of core medical equipment which would be exhaustive and/or universally applicable.

4.1. Training Capacity and Course Certification

Bloom suggests a comprehensive list of skills related to equipment management, for which training is required (Bloom, 1988). These skills include (a) selection of equipment, (b) writing and adjudicating tenders, (c) procurement, (d) operation of equipment, (e) maintenance of equipment, (f) equipment management. In his opinion the capacity and competence should be in place, either locally or externally, to provide instruction in these areas. Mallouppas emphasizes the need for training of national staff from managers to engineers and technicians, as well as users (Mallouppas, 1988). A number of developing countries have indeed developed National Training Centres, some of which are used as Inter-country Training Centres, sponsored by the World Health Organization and other international aid organizations. In the absence of specialized Training Centres, for example in Ghana, the development of basic skills, applicable to medical equipment services, can to some extent be provided by the national education system. In practice one will need to look at the technical training provided by various technical institutes, from Vocational Training Centres to Universities.

Mallouppas stresses that one needs to investigate and determine the available potential of local technical training institutions in providing training support in the field of maintenance and repair of health care equipment. He goes on to say that links between Regional Training Centres need to be established. In addition training by manufacturers and suppliers of equipment is regarded as an important source of skills development. Formal certification of in-country technical training courses for medical and paramedical staff provides a potential incentive for employees. McKie (1987) emphasizes that in order for a training scheme to be successful in producing the right quality and quantity of staff it is necessary that the assessment of merits leads to a certificate, diploma or degree, which in turn will guarantee an appropriate monetary award for graduates, which is meaningful in a national context.

5.0. Conclusion and Recommendation

Healthcare is increasingly becoming technology oriented. Sophisticated medical equipment is being used in almost all Healthcare sectors of the country. The Government, through the Ministry of Health import large volumes of medical equipment worth millions of Ghana Cedi yearly to be distributed in all Districts and Regional Hospitals of the country. Many a times, valuable medical equipment would lie idle in a hospital or healthcare centre for want of simple repairs or replacement of defective part(s). In Ghana, there is no Centre established to train middle level manpower in Medical Equipment Technology. This poses a huge challenge in achieving the MDG target on Health care delivery.

The minimal training provided to laboratory, X-ray or Ultrasonic equipment and apparatus operating technicians do not go beyond rudimentary operational procedures. These equipment are designed with strict safety standards; and in the event of a malfunction, the operators are lost on how to proceed. This affects the quality of healthcare delivery being provided in that hospital/centre adversely. In order to improve the quality of healthcare it is imperative that medical equipments are operational all the time. These equipments not only require special operational training but also their maintenance is very costly in monetary as well as opportunity term. To facilitate maintenance of these equipments the operators are required to be made more conversant with the technology, simple handling and maintenance processes. Thus there is a demand of having a ready availability of technically trained healthcare professionals to carry out timely repair, service and maintenance of these equipments. The solution therefore would be the establishment of TVET Centre for Medical Equipment Technology This Centre would develop the manpower needs of the country regarding: Health Care Technical Services, Medical Equipment Maintenance Management Systems and Medical Equipment Monitoring, either on a national level or on the level of privately operating agencies.

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