

Health Technology Management in Zambia

A Mapping Exercise in Copperbelt Province



April 2017

Shauna Mullally

Executive Summary

This report was commissioned by THET as part of its work on improving biomedical engineering capacity within Zambia. It presents the key findings of an exercise undertaken to map and analyze the HTM policies and procedures within Copperbelt health facilities, the province's Provincial Medical Office (PMO) and the MoH itself. The report aims to represent the key processes, institutions and practices related to HTM within the Zambian health system in order to establish a clear picture of medical equipment management from planning and budgeting activities at the Ministry of Health to maintenance and use of equipment in Zambian health facilities. The report does this in order to identify specific changes and activities required to improve HTM in the Zambian health system, and provide recommendations for ways forward in terms of HTM at central, provincial and facility level.

The report includes background information, an overview of the mapping methodology, key findings and recommendations for quality improvements at the facility, provincial and central levels. Additionally, it includes baseline data from health facilities, where available, for future quality improvement initiatives. Supporting /supplementary documentation and reference material has been provided to the Ministry of Health (MoH) and THET.

The fieldwork and interviews that form the basis of this report were conducted over a period of 7 weeks, between September 26th and November 11th 2016. A workshop with key health workers interfacing with medical equipment in Copperbelt province was held on November 10th, and a dissemination meeting was held with the Ministry of Health on 11th November 2016.

Sections 1-3 provide the introduction background and methodology of the report. Section 4 details the mapping exercise undertaken, and provides an overview of key policies, tools, standards and guidelines already in existence with the potential to contribute to the improvement of HTM practice in the Zambian health service. The key areas of exploration are:

- National strategic plans, including the National Health Strategic Plan, and the National Human Resources for Health Strategic Plan
- Facility, Provincial and Central level action plans, which include relevant and powerful tools for improvement such as SWOT and bottleneck analyses.
- Facility performance assessments, a powerful tool for the standardisation of HTM practices, and service quality improvement.
- Guidelines for the budgeting and planning of medical equipment including:
 - The medical equipment management guidelines and standard equipment lists produced during the Health Capital Investment Support project, as well as guidelines for periodic preventive maintenance.

It is noted that many of the guidelines, tools and processes explored in the section do not work as well as they could. It is observed that while efforts are made to streamline the national objectives, identified by the strategic plans, through all levels of service provision; there are several key areas where they are fundamentally disconnected. For instance, currently, the mechanism of performance assessment of health facilities is not linked to the quality improvement function. Likewise, standard lists for medical equipment and for maintenance personnel seem to be different at central, provincial and facility level.

Section 5 details the findings of the mapping exercise in terms of identified gaps in HTM practice. These are divided into sub-sections related to the lifecycle of medical equipment. Within the sphere of planning, budgeting and procurement, major challenges identified include:

- Inadequate funding for medical equipment in general.
- An over-emphasis in procuring new equipment at the expense of planning for the life-cycle costs of equipment. This includes maintenance and service contracts.
- Service contracts are often negotiated for already installed equipment, lessening the Ministry's bargaining power over terms.
- Communication between facilities and central planners is weak, resulting in facilities often not knowing what procurements are being planned for them, and their time of arrival.
- The lack of a strong national regulatory environment means that procured equipment is often of poor quality, and too much responsibility is placed on the CMEO who lacks access to relevant technical expertise.
- Equipment budgets are not 'owned' by their maintenance departments or users, and facilities cannot procure equipment internationally. The relative lack of local distributors, as well as the capacity of local procurement staff leads to higher costs and lengthy delays.

In terms of the lifecycle of equipment at the facility, which includes aspects of installation, commissioning, use, decommissioning and disposal, the major findings included:

- The terms and conditions of tender documents are often too generic when it comes to installation activities. This leads to sub-standard works by the contractors in installation and training activities which the facilities are ill-equipped to effectively monitor. They don't know what is expected of them and of the contractors.
- This can lead of inappropriate orientation at the moment the equipment is received. This is compounded by there generally being no formal user-training programmes at facilities. No formal training of users leads to equipment breakdown through user error.
- Also, a lack of functional test equipment leads to serious equipment and patient safety issues.

There are a number of issues related to the management and maintenance of equipment, the domain of trained Biomedical Engineers and associated professionals. Most of the challenges identified in this area are challenges for equipment maintenance professionals themselves. They include:

- The support for maintenance is still too low. The budget is insufficient to do anything other than firefight maintenance challenges. On top of this, there has been no major investment in providing technicians with adequately resourced workshops to carry out important maintenance tasks such as corrective and preventive maintenance, and safety testing.
- Up to date equipment inventories are crucial to effective planning, but they don't exist for all facilities, and the picture at provincial and central level is incomplete. Record keeping is generally very limited, even in areas like work request records, which would contain very useful information about frequency and reason for equipment breakdown. There is no unified digital equipment management system available to help inform equipment planning and budgeting.
- Until very recently there has been no formal training for medical equipment maintenance personnel, and the vast majority of maintenance staff do not have medical equipment specific training. The opportunities for continuing professional development are also limited.
- Given many of the issues mentioned above, the work of medical equipment maintenance personnel is hampered by lack of access to crucial resources. These include spare parts for their facility's equipment, and user/maintenance manuals. A more focused emphasis on maintenance from the planning and budgeting and procurement stages would assist greatly in the effectiveness of maintenance services.

Compounding the above issues is the human resources situation in medical equipment management and maintenance throughout the Zambian health service. There are not enough qualified people working in the area to provide an effective service. The report explores a number of ways that human resources could be increased via various internal MoH mechanisms, including the expansion of the current establishment, the unfreezing of current positions, and trade-offs for other unfilled positions. A recommendation is made for the Ministry to look at all of these options while attaining the goal of hiring graduates from the newly developed Diploma in Biomedical Engineering Technology.

The report then makes a series of specific recommendations, both immediate and mid-term, for the improvement of HTM within the Zambian health service. Most of these are aimed at the MoH and discuss ways that gains to HTM service delivery could be made through certain key initiatives from the central level. Cardinal among these are:

- The development of more appropriate procurement practices that take into account the life-cycle needs of medical equipment. Including the quality of equipment, the supply of spare parts, ensuring the inclusion of maintenance manuals in English.
- Overhauling the management of service contracts. Ensuring that these are negotiated at the point of purchase, and ensuring that they are in operation for a longer period (3-5 years).
- Developing a 'business case' for equipment maintenance focusing on the cost-benefit analysis of investing in maintenance against the current practice of investing in new equipment. This would be a powerful planning tool and allow the Ministry to see where cost savings could be made.
- Invest in the development of a nationwide equipment management system based on updated inventories to aid in the planning for and budgeting for equipment.
- Develop a nationwide strategy for medical equipment maintenance personnel, and ensure that graduates are hired from the newly developed Biomedical Engineering Technology courses and appropriately deployed.

The report also makes a series of recommendations for service quality improvement projects that could make substantial changes at the facility level in terms of maintenance service delivery. These project ideas focus on specific management improvements, such as the expansion of work request data collection, or expanding user training and preventive maintenance programmes, that could make real changes to the effectiveness of maintenance services within facilities, while also collecting key data for provincial and central level initiatives.

The adoption of these recommendations over the next few years has the potential to greatly increase efficiency and cost savings in the area of medical equipment within the Zambian health service. Improvements to equipment planning, procurement, management and maintenance, can be a key driver in improving equipment safety and uptime, leading to more positive health outcomes, the improvement and expansion of medical procedures, and greater confidence in the Zambian health service.

Acknowledgements

This report has been prepared by an independent consultant, Ms. Shauna Mullally, for the Ministry of Health and the Tropical Health and Education Trust in Zambia. The consultant is very grateful to all those who provided their time and shared their expertise and experiences freely during the mapping exercise and in the preparation of this report.

Administrative support for the work was provided by the Copperbelt Provincial Medical Office in Ndola and the Tropical Health and Education Trust Zambia office in Lusaka. Particular thanks must be extended to the following individuals for their considerable administrative and content-related contributions:

Mr. Patrick Mumba, Provincial Medical Equipment Officer, Copperbelt PMO
Mr. Gilbert Musonda, Chief Medical Equipment Officer, MoH Zambia
Mr. Misheck Kasaro, Programme Officer, THET Zambia
Mr. Edward Tonkin, Programme Manager, THET Zambia

Many individuals contributed to the mapping exercise presented in this report, but full responsibility for the content rests with the consultant. The views expressed in this report may not necessarily reflect those of the MoH, THET or any personnel interviewed during the work.

Acronyms

ADCH – Arthur Davidson Children’s Hospital (Ndola, Zambia)

BME – Biomedical Engineering

BMET – Biomedical Engineering Technologist

CDH – Cancer Diseases Hospital (Lusaka, Zambia)

CED – Clinical Engineering Division of the IFMBE

CMEO – Chief Medical Equipment Officer (Position at the MoH)

CP – Cooperating Partner (Non-Governmental actor working collaboratively with GRZ)

DCCDS (or CC&DS) – Directorate of Clinical Care and Diagnostic Services (Directorate within MoH)

DFID – The UK Government’s Department for International Development

DTSS – Directorate for Technical Support Services (former Directorate within MoH)

EHT – Environmental Health Technician

EmONC – Emergency Obstetric and Newborn Care

FSE – Field Service Engineer

GRZ – Government of the Republic of Zambia

HCIP – Health Capital Investment Plan

HCISP – Health Capital Investment Support Project (Project run by JICA in Zambia beginning in 2010)

HP – Health Post (Smallest health facility type in Zambia)

HR/HRH – Human Resources/Human Resources for Health

HTM – Health Technology Management

IFMBE – International Federation for Medical and Biological Engineering

JICA – Japanese International Cooperation Agency

KANDO – Kitwe and Ndola Hospital Management Project (1995-1998) supported by DFID

KCH – Kitwe Central Hospital (Kitwe, Zambia)

L1, L2, L3 Hospital – Refers to different levels of hospital in Zambia: Level 1 (District), Level 2 (Provincial) and Level 3 (Tertiary/Referral)

MDG – Millennium Development Goals (United Nations – 2000-2015)

ME – Medical Equipment

MEC – Medical Equipment Committee

MoH – Ministry of Health (Zambia)

MoJ – Ministry of Justice (Zambia)

NCH – Ndola Central Hospital (Ndola, Zambia – now Ndola Teaching Hospital)

NHSP – National Health Strategic Plan (Zambia) – Unless otherwise stated refers to 2011-2015 Strategic Plan

NHRHSP – National Human Resources for Health Strategic Plan

NORTEC – Northern Technical College (Ndola, Zambia)

ORET - Ontwikkelings Relevant Export Transakie (Project of the Dutch Cooperation Agency supplying imaging, theatre, and monitoring equipment.

PA – Performance Assessment

PCB – Printed Circuit Board

PLAMAHS – Planning and Management of Assets in Health Services (Asset management software developed for low-resource health services by Health Partners International)

PMEO – Provincial Medical Equipment Officer (Position within MoH based at the PMO's office)

PMO – Provincial Medical Officer (Position within MoH)

PS – Permanent Secretary (Highest level of civil servant in Zambia)

QC/QA – Quality Control/Quality Assurance

QI – Quality Improvement

RHC – Rural Health Centre (Health facility in Zambia below the level of District (L1) Hospital)

SAFE – Safer Anaesthesia from Education (An initiative delivering Anaesthesia training to mostly non-Physician practitioners to improve and standardise Anaesthesia practice – developed by the World Federation of Societies of Anaesthesiologist (WFSA) and the Association of Anaesthetists of Great Britain and Ireland (AAGBI) and supported by THET)

SAG – Sector Advisory Group

SQA – Service Quality Assessment

TEVETA – Technical, Entrepreneurial, Vocational Education Training Authority (Zambia)

THET – The Tropical Health and Education Trust

UHC – Urban Health Centre (Health facility in Zambia below the level of District (L1) Hospital)

WHO – World Health Organisation

ZMW – Zambian Kwacha (Currency)

ZPPA – Zambia Public Procurement Authority

Table of Contents

1	Background	17
2	Methodology	18
2.1	Facility visits	19
2.2	Interviews and data collection	19
2.3	Workshop.....	19
2.4	Dissemination meeting.....	20
3	Mapping of policies, planning tools, standards and guidelines	21
3.1	General planning and budgeting.....	21
3.1.1	National Health Strategic Plan (NHSP).....	21
3.1.2	Action plans.....	23
3.1.3	Performance assessments.....	30
3.1.4	Quality improvement.....	32
3.2	Human resource planning and budgeting	32
3.2.1	National human resources for health strategic plan (NHRHSP).....	32
3.2.2	Post establishment and assignment	33
3.2.3	Staffing prototypes.....	33
3.2.4	Planning and budgeting tool for facilities.....	34
3.3	Planning and budgeting for medical equipment.....	34
3.3.1	Medical equipment management guidelines	34
3.3.2	Standard equipment lists	35
3.3.3	Standard manufacturers and models for medical equipment ...	36
3.3.4	Guidebook for budget allocation for periodic preventive maintenance of medical equipment and infrastructure.....	36
3.3.5	Guidelines on donations of equipment to Ministry of Health	36

3.3.6	Guidelines on receiving new equipment and equipment donations	37
3.4	Procurement of new medical equipment.....	37
3.5	Installation and commissioning of medical equipment	37
3.6	Maintenance and management of medical equipment	37
3.7	Training for medical equipment personnel	37
3.8	Decommissioning and disposal.....	38
4	Findings	39
4.1	Planning and budgeting for new equipment.....	39
4.1.1	Central level - current picture	39
4.1.2	Central level – findings	40
4.1.3	Central level – recommendations	41
4.1.4	Provincial level – current picture.....	41
4.1.5	Provincial level – findings	41
4.1.6	Provincial level – recommendations	42
4.1.7	L3/L2 facility level – current picture.....	42
4.1.8	L3/L2 facility level – findings	43
4.1.9	L3/L2 facility level – recommendations	44
4.1.10	District level – current picture	44
4.1.11	District level – findings.....	44
4.1.12	District level – recommendations	44
4.2	Procurement of new equipment.....	45
4.2.1	Central level - current picture	45
4.2.2	Central level – findings	46
4.2.3	Central level – recommendations	46
4.2.4	Provincial level – current picture.....	47

4.2.5	Provincial level – findings	47
4.2.6	Provincial level – recommendations	47
4.2.7	L3/L2 facility level – current picture.....	47
4.2.8	L3/L2 facility level – findings	48
4.2.9	L3/L2 facility level – recommendations	49
4.2.10	District level – current picture	49
4.2.11	District level – findings.....	50
4.2.12	District level – recommendations.....	50
4.3	Installation and commissioning.....	50
4.3.1	Central level - current picture	50
4.3.2	Central level – findings	50
4.3.3	Central level – recommendations	51
4.3.4	Provincial level – current picture.....	51
4.3.5	Provincial level – findings	51
4.3.6	Provincial level – recommendations	52
4.3.7	L3/L2 facility and district level – current picture.....	52
4.3.8	L3/L2 facility and district level – findings.....	52
4.3.9	L3/L2 facility and district level – recommendations.....	53
4.4	Use	53
4.4.1	User training.....	53
4.4.2	User maintenance.....	53
4.4.3	Equipment safety	53
4.5	Decommissioning and disposal.....	53
4.6	Equipment management.....	54
4.6.1	Planning and budgeting for maintenance.....	54
4.6.2	Inventory.....	55

4.6.3	Equipment management systems.....	55
4.6.4	Service contract management.....	55
4.7	Equipment maintenance.....	56
4.7.1	Training.....	56
4.7.2	Corrective maintenance.....	56
4.7.3	Preventive maintenance (PMs).....	57
4.7.4	Work requests and record keeping.....	57
4.7.5	Spare parts procurement.....	58
4.8	Human resources for medical equipment.....	59
4.8.1	Central level.....	59
4.8.2	Provincial level.....	59
4.8.3	Facility level.....	60
5	Recommendations for improving HTM at Central Level.....	62
5.1	Short-term recommendations.....	62
5.1.1	Management.....	62
5.1.2	Strategy.....	62
5.2	Mid-term recommendations.....	63
5.2.1	Medical equipment procurement.....	63
5.2.2	Medical equipment service contract management.....	63
5.2.3	Developing a 'business case' for investment in BME personnel and systems.....	64
5.2.4	Partnering to offer more in-service BME training.....	65
5.2.5	Advocacy and sensitization with partners to build BME capacity.....	65
5.2.6	Exploring the set up of an equipment management system.....	65
5.2.7	Developing a country-wide strategy for BME personnel.....	66
6	Recommendations for provincial level service quality improvement.....	67

7	Recommendations for facility level service quality improvement	68
7.1	General areas of recommendation.....	68
7.2	QI project process.....	69
8	Conclusions.....	72
9	APPENDICES	74
9.1	APPENDIX A – Terms of reference.....	74
9.2	APPENDIX B – Interview and facility visit schedule.....	77
B.4	Partners visit schedule.....	79
9.3	APPENDIX C – Interviewees and contacts.....	80
9.4	APPENDIX D – Relevant medical equipment content in the 2011-2015 HNSP	85
9.5	APPENDIX E – Indicative annual action planning timeframe.....	86
9.6	APPENDIX F – Medical equipment content from planning handbooks – all levels	88
9.7	APPENDIX G – Preventive and corrective maintenance bottleneck analysis for Copperbelt PMO draft action plan.....	91
9.8	APPENDIX H – Proposed medical equipment staffing structure	94
9.9	APPENDIX I – MoH standard medical equipment makes and models proposal	98
9.10	APPENDIX J – Useful training materials	103
9.11	APPENDIX K – Publicly available medical equipment specifications.....	105
9.12	APPENDIX L – Summary of BME personnel’s involvement in HTM within their facilities	106
9.13	APPENDIX M – Medical equipment workshop resources	114
9.14	APPENDIX N – List of supporting documentation supplied.....	120

Introduction

Appropriate, functional medical equipment must be available in adequate quantities to deliver health services effectively. It is an essential component of health service delivery; without it, patients cannot be properly diagnosed, monitored, treated or rehabilitated.

The management and maintenance of medical equipment is called health technology management (HTM). HTM brings together multiple stakeholders within health facilities and the health system to plan and budget for, procure, install and commission, use and train on, maintain and manage, and finally decommission and safely dispose of the medical equipment required for service delivery. It depends on well-trained and resourced medical equipment personnel within the system to lead and contribute to the activities across the medical equipment life cycle.

The issues facing medical equipment, HTM and BME personnel in Zambia have been well documented by reports published by and for the MoH with support from THET, JICA and other CPs over the years. Together, these sources of information paint a picture of the challenges faced and measures taken to address them.

The focus of this work is to complement this body of knowledge by *identifying specific facility-level HTM policies and procedures and relating them to provincial and central level policies and procedures*. This is carried out in order to identify key areas of improvement in HTM practice at central, provincial and facility levels. It also identifies how best to optimize the skills of Zambia's first BMET graduates and ensure that they are effectively utilized and given every opportunity to successfully carry out their duties.

1 BACKGROUND

The Copperbelt, like all provinces in Zambia, faces challenges with effective HTM due to restrained budgets, limited medical equipment or biomedical engineering (BME) personnel, and coordinating equipment-related activities across different levels of the health system.

Copperbelt Province is comprised of ten districts, of which three are rural, and has a population of approximately 2.23 million according to the Provincial Medical Office (PMO). The province was selected as the site of this mapping exercise for several reasons.

First of all, it is home to NORTEC, the technical college in Ndola where Zambia's first biomedical engineering technologist (BMET) diploma program is run. THET supported the development of the program in response to a request from the MoH and currently supports the running of the program. The first cohort of graduates will graduate during 2017.

Of these 21 graduates, 3 will return to their previous positions within MoH hospitals fully qualified for their roles, and the remaining 18 will be ready to join the workforce in Zambia. These graduates will be the first qualified BMETs trained in Zambia to enter the workforce.

Secondly, Copperbelt Province is the location of the majority of Zambia's current level 3 hospitals: Ndola Central Hospital (NCH), Kitwe Central Hospital (KCH) and Arthur Davison Children's Hospital (ADCH).

Thirdly and finally, the province has a significant amount of industry, particularly due to the mines, which supplies and sometimes provides technical services for the equipment in MoH facilities. Many equipment suppliers outside of Lusaka are based in Kitwe and Ndola. Therefore, the province is also likely to absorb some of the new BMET graduates that will work outside of MoH facilities.

2 METHODOLOGY

The methodology was developed to meet the Terms of Reference (ToR) for the assignment, which are presented in [APPENDIX A](#). This included developing a schedule for facility visits and interviews, developing semi-structured questionnaires for interviewees, collecting and reviewing secondary data in the form of MoH and facility level documentation on policies, practices and tools and analysing the aggregated data to summarize findings and make recommendations.

The work required to meet the ToR was primarily undertaken based out of the Copperbelt's Provincial Medical Office (PMO) in Ndola with support from the Provincial Medical Equipment Officer (PMEO) and planning staff within the office from 03 Oct – 09 Nov 2016. The work included interviews and baseline data collection during visits to select Copperbelt health facilities and at the PMO.

Furthermore, two weeks during the assignment period were spent in Lusaka interviewing and collecting data from various MoH stakeholders and cooperating partners. This Lusaka-based work was supported heavily by the Chief Medical Equipment Officer (CMEO) within the MoH Directorate for Clinical Care and Diagnostic Services and provided vital central-level information for the work.

On 10 Nov 2016, the PMO and THET hosted a one day workshop in Kitwe for HTM stakeholders from Copperbelt health facilities to share the preliminary findings and to gather their inputs on QI and technical assistance recommendations. The following day in Lusaka, a dissemination meeting was held with members of the MoH's newly formed central Medical Equipment Committee.

The medical equipment life cycle was used as a basis for structuring the content of the interviews and data analysis. Figure 1 presents the life cycle:

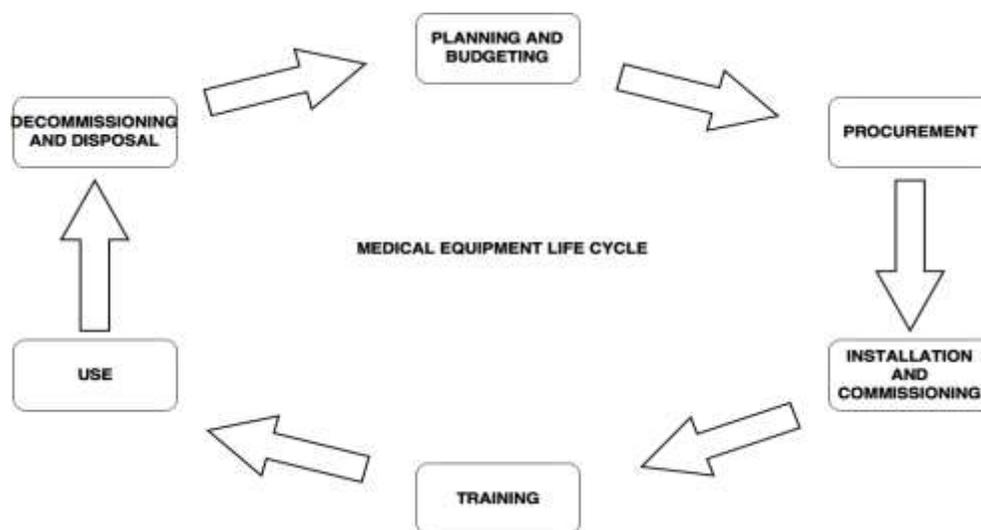


Figure 1: Medical equipment life cycle

Equipment maintenance and management activities, managed by BME professionals, should contribute to all stages of the medical equipment life cycle for effective HTM. Figure 2 presents these activities:



Figure 2: Medical equipment management and maintenance activities

2.1 FACILITY VISITS

Targeted Copperbelt health facilities were identified in the ToR. This list was adapted in consultation with the PME0 to focus on additional higher level health facilities that had in-house equipment maintenance staff and to ensure adequate time was spent gathering information at each facility. For example, three separate visits were required to both level 3 (L3) hospitals to gather adequate data. The full facility visit schedule is provided in [APPENDIX B](#).

2.2 INTERVIEWS AND DATA COLLECTION

Semi-structured interviews formed the basis of all primary and secondary data collection involved in the work. At facility level, baseline data was collected on equipment inventories and maintenance records where available, and tools were used to assess both the maintenance workshop resources available within the facility and the BME personnel's involvement in HTM across the equipment life cycle. The full list of interviewees within health facilities, the PMO, the MoH and CPs is provided in [APPENDIX C](#).

2.3 WORKSHOP

On 10 Nov 2016, the Copperbelt PMO and THET hosted a one-day workshop to bring together a range of HTM stakeholders from facilities within the Copperbelt to provide them with information about THET's work, the BMET program at NORTEC, the PMO's medical equipment work and priorities and to share and validate the findings of the mapping exercise.

A total of 24 facility personnel attended the meeting, including administrators, planners, equipment users and maintenance personnel. They provided feedback and recommendations on high-level

areas for QI projects within their facilities, and required improvements in practices at central level to improve downstream HTM and maintenance practices. This included the identification of new areas for consideration related to procurement and improved information exchange and coordination with the central level on medical equipment issues.

The workshop slides are included in the supporting documentation. [Appendix N](#) provides a list of all supporting documentation included in the package for the use of THET and the MoH.

2.4 DISSEMINATION MEETING

On 11 Nov 2016, the preliminary findings of the mapping were presented to the members of the newly formed central level Medical Equipment Committee (MEC). The meeting was organized by the CMEO and chaired by the Deputy Director of Clinical Care and Diagnostic Services. Presentations from THET and NORTEC's BMET program preceded the presentation of preliminary findings to the meeting.

The group provided feedback on the recommendations for central-level improvement through the means of proposed technical assistance and suggested an additional area of focus to develop a human resource (HR) strategy for graduating BMETs and BME personnel nationally. The committee members also shared valuable learnings from their own areas of expertise related to cadre development, internships, procurement and service contract challenges and management systems.

The meeting slides are included in the supporting documentation.

3 MAPPING OF POLICIES, PLANNING TOOLS, STANDARDS AND GUIDELINES

The Ministry of Health has developed policies, plans, tools, standards and guidelines that relate to medical equipment and its life cycle management. This section provides an overview of general policies, planning tools, standards and guidelines that relate to medical equipment and also those policies, tools, standards and guidelines that have been developed specifically for medical equipment. These will be referenced also throughout the findings section of this report and they present opportunities to embed quality improvements in existing MoH frameworks.

3.1 GENERAL PLANNING AND BUDGETING

3.1.1 National Health Strategic Plan (NHSP)

The national health strategic plan (NHSP) outlines the health system's priorities and plans over a five-year period. All activities and interventions undertaken at the central, provincial and facility level must relate to the NHSP, which also guides priorities for cooperating partners' (CPs') support. The 2011-2015 plan was extended through 2016; currently the MoH is drafting the 2017-2021 plan.

The strategic direction for medical equipment outlined in the 2011-2015 NHSP is: "to ensure the availability of adequate, appropriate and well-maintained medical equipment and accessories in accordance with service delivery needs at all levels." They two key medical equipment strategies in the plan relate to investment in new equipment and capacity building for medical equipment maintenance and management of equipment.

Three specific activities outlined in the plan to support this direction are:

- a) "Finalize policy to support acquisition, management and maintenance of medical equipment;
- b) Develop capacity program for management and maintenance of medical equipment; and
- c) Develop standard equipment lists at 2nd and 3rd level hospital facilities."

The 2011-2015 plan notes that more investment in new and replacement medical equipment is required for health facilities. Medical equipment and infrastructure requirements are outlined in the health capital investment plan (HCIP). The lack of medical equipment is identified as a barrier to commissioning new facilities, as well as providing services at existing ones. Inadequate maintenance budgets at the facility level are also identified as a barrier, as well as the lack of qualified personnel.

Figure 3 presents the Strengths, Weaknesses, Opportunities and Threats (SWOTs) identified for medical equipment in the 2011-2015 NHSP.

3. Medical Equipment				
	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
	<ul style="list-style-type: none"> • Availability of Standard Equipment List for Level 1 facilities. • Existence of budget line for equipment. • Upgraded equipment through the ORET project. • Procured MRI and CT Scan at CDH. • Entered into service contracts for major equipment. • Introduced the position of medical equipment maintenance officers in the new MOH staffing structure. 	<ul style="list-style-type: none"> • Lack of management policy/standards for medical equipment. • A lot of health facilities have been constructed but remain unutilised because of lack of equipment. • Inadequate funding for high-end technology acquisition. • Maintenance problems: shortage of maintenance officers, lack of maintenance workshops at hospital level, and inadequate funding. 	<ul style="list-style-type: none"> • Political will to address equipment issues. • Reduction in external costs for equipment maintenance and for specialised care abroad. • Potential for production of maintenance officers at NORTEC. • Availability of equipment in private facilities. • Support from CPs. 	<ul style="list-style-type: none"> • Limited choices on sourcing of equipments and spare parts. • Limited capacity to negotiate with manufacturers on pricing of equipment. • High operational and maintenance costs.

Figure 3: Medical equipment SWOT analysis from 2011-2015 NHSP

The plan outlines the following priorities for new equipment procurement from 2011-2015: laundry and kitchen equipment (note: these are not technically medical equipment but are procured and managed by the medical equipment unit), theatre and anaesthesia equipment, maternity equipment, central sterilization services department (CSSD) equipment and general bedside nursing equipment.

The plan specifically notes “the need to determine criteria to determine human resource needs for equipment management and maintenance at hospital level, the need to develop appropriate maintenance facilities with appropriate tools, test and calibration equipment, develop and implement systems for maintenance and management.” Inadequate equipment and maintenance is identified as a weakness to service delivery in the plan’s SWOT analysis.

The NHSP is reviewed mid-way through its implementation period. This review is led by the MoH and engages provincial and facility level leadership as well as CPs. The plans and priorities outlined in the NHSP provide the framework for the annual action planning exercises that take place at the central, provincial, facility and district levels. These action plans present activities and associated budgets for each office and facility, including for medical equipment.

[APPENDIX D](#) presents a summary of the 2011-2015 NHSP sections that are relevant to medical equipment. Medical equipment planning for the 2017-2021 NHSP will occur in Quarter 4 2016 – Quarter 1 2017. Future planning sessions represent a significant opportunity to incorporate some of the priority areas identified in the recommendations section of this report.

3.1.2 Action plans

Action plans are developed at the central level, the provincial level, the facility level for levels 2 and 3 hospitals, and the district level, including level 1 hospitals, health centres and health posts. They include five main sections: introduction, hospital profile, situation analysis, plan and budget. The action planning process begins in April of each year and runs until the end of October (approximately). [APPENDIX E](#) provides an overview of the target timeframe for the action planning activities.

Planning handbooks provide guidance for each office and facility on the action planning process. The action plans are updated annually and cover the period of the next three years on a rolling basis. They form the basis of each office and facility's budget request to parliament for the following year.

3.1.2.1 Planning handbooks for different levels

The planning handbooks provide guidance to offices and facilities on action plan development and implementation. These planning handbooks include various sections related to the planning and budgeting of medical equipment. [APPENDIX F](#) provides an overview of medical equipment related content for each planning handbook. The handbook for central and provincial planning in particular contains lots of rich detail on the overall planning processes and annual timelines within the MoH as a whole.

In addition to the four planning handbooks covered in [APPENDIX F](#), a fifth planning handbook exists for statutory boards, such as service providers and regulators. This handbook includes some of the same generic medical equipment content as the others such as a section template for medical equipment maintenance problems and harmonized cost codes for various equipment-related budget line items.

3.1.2.2 Central level action plan

This action plan guides annual activities at the central level. The Chief Medical Equipment Officer (CMEO) of the medical equipment unit within the Directorate for Clinical Care and Diagnostic Services (DCCDS) prepares the medical equipment inputs to this plan in consultation with other unit leads and program leads. The specific medical inputs prepared by the CMEO are the medical equipment narrative, activity overview and budget projection.

The medical equipment narrative includes an overview of the main objectives of the medical equipment unit and the MoH's priorities for medical equipment modernization that guide activities undertaken. It also includes a review of the current year's budget allocation per activity for the unit vs. funds released.

The activity overview and budget projections include the upcoming year's budget allocation per activity vs. funds projected, highlighting gaps. For example, for the 2017 activities and budget allocation covers:

1. Procurement of new medical equipment
2. Procurement of service contracts
3. Procurement of hospital linen
4. Unit technical support activities, such as the annual PME0 meeting and quarterly supervisory visits to select provinces to provide guidance on equipment maintenance and management
5. A new teleradiology initiative to bridge the gap between the recent availability of high end imaging equipment and improved diagnostic services due to the lack of radiology staff available

Note that there are generally budget deficits for all activities, and support must be sought from CPs. As part of the action planning process, the CME0 also disseminates these central level medical equipment plans and priorities to the PME0s in approximately June each year so they can develop their plans around these and brief the facilities within their provinces. This briefing happens during a meeting when funding support allows; otherwise it is ad hoc information sharing over the phone, etc.

Medical equipment is also touched upon in different sections of the central action plan prepared by service units that rely on functional equipment, such as medical imaging, anaesthesia and critical care, nursing care, paediatrics, laboratory services, prosthetics and orthotics, etc. All of these units identify equipment as a critical area in their narratives.

While these sections don't include procurement activities for new equipment for their areas because the medical equipment unit leads this activity with their input, they do include procurement activities for reagents and accessories, and QC/QA materials for laboratory and imaging equipment specifically. None of these units include user training on medical equipment but most include training activities that are assumed to have an equipment component, such as for example a SAFE obstetric anaesthesia course.

The 2016-2018 action plans for the following MoH units are included in the supporting documentation:

- Medical equipment
- Anaesthesia and critical care
- Laboratory
- Medical Imaging
- Nursing
- Paediatrics and ARV
- Nuclear Medicine
- Prosthetics and Orthotics

More specific information about the medical equipment component of the central level action plan is provided in [Section 5.1.1.1](#).

3.1.2.3 Provincial level action plan

Provincial level action plans outline each province's plan for meeting the NHSP and MDG priorities. The medical equipment content found in a PMO's action plan differs from that found at the central and facility levels, in large part because PMOs are not involved in planning and budgeting for, or procuring, new medical equipment.

Instead the medical equipment function within the PMO facilitates these activities between the facilities and the central level. This function, led by the Provincial Medical Equipment Officer (PMEO), also provides technical support for equipment installations, inventories, repairs and – budget permitting – preventive maintenance.

The Copperbelt PMO's action plan therefore covers medical equipment activities related mainly to installations, repairs and preventive maintenance. Like the central level plan, it also includes many references to the poor state of equipment and maintenance inadequacies impacting on service delivery in various clinical and service areas.

The plan also includes a provincial-level SWOT analysis for medical equipment, which remained largely unchanged for the 2016-2018 and 2017-2019 plans. The only change for the 2017-2019 plan, which was in draft format during the mapping, was the addition of the new program at Evelyn Hone as an opportunity for more potential BMET graduates in Zambia. Table 1 presents the current SWOT analysis.

Table 1: Medical equipment SWOT analysis from draft 2017-2019 Copperbelt PMO action plan

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> • Availability of funds for medical equipment maintenance • Availability of medical equipment management guidelines in hospital and districts 	<ul style="list-style-type: none"> • Reduced medical equipment maintenance funding • Inadequate corrective and preventive maintenance in medical equipment • Inadequate skills in equipment installations and 	<ul style="list-style-type: none"> • Availability of cooperating partners and stake holders who are funding the MoH • Good road network • Proximity of towns • Availability of other medical 	<ul style="list-style-type: none"> • Inadequate funding to cover all capital equipment • Lack of service manuals and spares for old medical equipment • Inadequate service level agreements

<ul style="list-style-type: none"> • Availability of standard equipment lists for health centres, 1st, 2nd, and 3rd level hospitals • Installation of equipment distributed to some health facilities is on going • Transport availability to help in monitoring of infrastructure projects 	<p style="text-align: center;">maintenance of modern equipment</p> <ul style="list-style-type: none"> • Inadequate training of equipment user resulting in the mishandling and non-use of equipment • Inadequate medical equipment technicians • Inadequate skills in using modern medical equipment by end users • Lack of diagnostic and testing tools for medical equipment • Poor medical equipment inventory taking • Un-commissioned health facilities due to unavailability of medical equipment • Uncompleted infrastructure 	<p style="text-align: center;">equipment suppliers such as Phillips and Siemens</p> <ul style="list-style-type: none"> • Availability of contractors • Availability of training institutions such as Northern Technical and Evelyn Hone colleges for medical equipment technologists • Availability of stakeholders in the construction of health facilities, training and funding 	<ul style="list-style-type: none"> • No back up for specialised medical equipment • Delayed release of funds from ministry of finance for infrastructure projects
---	---	---	---

	projects under community modes		
--	--------------------------------	--	--

The draft plan includes six medical equipment activities to be undertaken by the PME0:

1. Installing and commissioning newly acquired equipment
2. Performing preventive and corrective maintenance
3. Delivering training to users and maintenance leads
4. Taking and updating medical equipment inventories
5. Supporting and supervising facilities to implement the health facility management guidelines (developed with JICA support for the HCISP, also included in the supporting documentation)
6. Bi-annual meetings with medical equipment technicians

It must be noted that while regular meetings between the PME0 and the province's medical equipment technicians are a vital opportunity to share information and receive technical training and guidance, they have not been taking place in recent years due to funding restrictions. More detailed information about the medical equipment activities in the Copperbelt PMO's action plan, including the proposed budget, is provided in [Section 5.1.1.4](#).

The plan also includes a bottleneck tracer analysis for the second activity, preventive and corrective maintenance, which was identified as a key bottleneck to scaling up effective service delivery in the province. The tracer analysis includes an analysis of the five main implementation challenges defined by the MoH: availability of essential commodities and human resources; accessibility; initial utilization; timely, continuous utilization; and effective quality.

The full analysis, presented in [APPENDIX G](#), provides a richly detailed overview of the underlying causes of the implementation challenges and proposed solutions. The proposed operational strategies and solutions and specific activities to be undertaken are excerpted below in Table 2 to provide context for PMO plans and involvement in any facility level improvement work that may be undertaken in 2017:

Table 2: PMO proposed strategies and activities to improve preventive and corrective maintenance

PROPOSED OPERATIONAL STRATEGIES/SOLUTIONS	SPECIFIC ACTIVITIES TO BE DONE
<ul style="list-style-type: none"> • Construction of maintenance workshops in all health facilities • Plan to procure the needed tools and instruments 	<ul style="list-style-type: none"> • Plan for the construction of maintenance facilities • Procure equipment assessment tools and instruments

<ul style="list-style-type: none"> Plan to procure and stock spares and consumables 	<ul style="list-style-type: none"> Procure and stock spares and consumables
<ul style="list-style-type: none"> Lobby for the creation of these staff positions in facilities that do not have Identify staff to send for training in medical equipment engineering 	<ul style="list-style-type: none"> Make submission to MoH HQ through HR Submit list of recommended staff to go for training
<ul style="list-style-type: none"> Facilities to be provided with the services of equipment technicians 	<ul style="list-style-type: none"> Make timely submission of requests for equipment technicians through PHO
<ul style="list-style-type: none"> Develop schedules for all maintenance works 	<ul style="list-style-type: none"> Hospitals and Districts to form Medical Equipment Management Committees Institutions to conduct medical equipment assessments Submit quarterly updated inventory to PHO
<ul style="list-style-type: none"> Plan for the procurement of needed tools, spares and service manuals Institutions to plan for their staff training 	<ul style="list-style-type: none"> Purchase needed equipment assessment tools, spares and service manuals Technicians to undergo regular updates on new advanced equipment available in hospitals

The activities listed in the table are funding dependent, but provide a good overview of the strategic direction the Copperbelt PMO would like to take regarding medical equipment maintenance. More specific information about the medical equipment component of the Copperbelt PMO action plan is provided in [Section 5.1.1.4](#).

3.1.2.4 Level 3 and level 2 hospital action plans

L3 and L2 hospitals prepare their own action plans. These include five main sections:

1. Introduction and overview of the plan and budget
2. Overview of hospital profile covering clinical services, specialist clinics available, social demographic of catchment area, etc.
3. Situation analysis covering hospital's epidemiological profile, staffing, finance, leading causes of morbidity and mortality, transport and communications, drugs and supplies, etc. (no specific section on medical equipment)
4. Main part of plan covering:
 - a. Progress on previous year's action plan
 - b. SWOT analyses

- c. Bottleneck analyses
 - d. Logical framework (activities)
 - e. Cost framework (budgets)
 - f. Training plan
5. Detailed description of the hospital's intended activities and budgeting spreadsheets, including a list of all new medical equipment the facility requires

Inadequate functional medical equipment is listed as one of the main challenges most facilities face. It is listed frequently in bottleneck analyses in the plans, which present the results of a 'planning or monitoring exercise to determine where impediments exist to reaching desired [service delivery] goals'.

Most SWOT analyses in the action plans include equipment breakdowns and lack of availability as a key threat to service delivery. Statistics on services that are impacted by equipment issues are also included in various sections of the action plans. For example, Table 3 presents the radiology test service indicators in Ndola Central Hospital's 2016-2018 action plan:

Table 3: Example of hospital action radiology service statistics

Type of Examination	Number of Tests			Comments
	Year 2015	Year 2014	Year 2013	
Medical Examinations	765	2,011	1,755	Reduced due to breakdown of X-ray equipment from September to January
Special Investigations	211	206	1,154	Reduced due to equipment breakdown, and unavailability of fluoroscopic unit
Routine Investigations	12,368	23,225	28,023	Equipment breakdown. Reduced number of unnecessary and repetitive examinations as planned
Emergencies	649	1,055	2,312	Reduced number due to equipment breakdown, SOP introduction and adherence, and introduction of CT scan services that replaced many examination modalities

Ultrasound	6,930	8,650	12,640	Reduction due to breakdown of two ultrasound scanners
------------	-------	-------	--------	---

L3/L2 hospital action plans also include maintenance budgets, which are generally much too small to support a preventive maintenance program, let alone cover all of the spare parts requirements in a given year. For example, the maintenance budget of one large facility is 2% of the overall budget, and this includes both medical and non-medical equipment maintenance.

One critical challenge identified with how budgets are prepared in the action plans is that the repair budget for medical equipment is combined with the budget for repair of furniture, and sometimes of general infrastructure also. Without a dedicated budget line it is very hard to ring fence funding. In reality, funding for spare parts comes either from departmental budgets or emergency funding re-allocations at the management levels; more information on this is provided in [Section 5.1.1.7](#).

3.1.2.5 District action plans

District action plans cover L1 hospitals, health centres, health posts and the district office itself. They also include equipment requirements although sometimes these lists do not contain an actual list of equipment; they just list 'procure medical equipment' as a planned activity with an associated budget request for the year. This budget tends to be very low, i.e. less than ZMW 30,000 per year for all facilities in a district. Often the budget for requested medical equipment is less than that for office furniture in a particular district.

District action plans also include a section on budgeting for maintenance costs, although the budget for medical equipment is combined with medical furniture and infrastructure and also tends to be less than ZMW 30,000 per year. Some districts indicate no budget request for maintenance in their plans (i.e. ZMW 0). Their reporting on cold chain equipment, which is closely linked with community level vaccination activities, is more comprehensive and includes an overview of the functionality of cold chain equipment at each facility in the district, as well as maintenance cost projections based on actual equipment status.

It is recommended this type of reporting be replicated for medical equipment over a particular value/complexity threshold.

3.1.3 Performance assessments

Performance assessment (PA) exercises take place twice annually at each level within the MoH, typically during Q3 to assess Q1 and Q2 performance, and Q1 of the following year to assess Q3 and Q4 performance. The MoH's Directorate for Technical Support Services (DTSS) has governed this overall process at the central level. The purpose of the PA is to assess a facility or office's progress

against its planned activities, identify barriers to implementation and discuss possible solutions to address these barriers.

The PA tool includes minimum acceptable standards for various areas within each facility/office such as governance, financial management, procurement, service delivery, etc. The tool includes two specific indicators for medical equipment maintenance and management effectiveness that are consistent for all levels, i.e. HP, HC, L1, L2 and L3 facilities:

1. Preventive maintenance schedule in place and implemented
2. Quarterly updated inventory of equipment, including state of repair

The PA tool also includes a list of minimum equipment required in different areas of the facility, such as the theatre, labour ward, etc. This list is included as a minimum acceptable standard in the tool. Prior to the PA visit, a facility/office will prepare their self-assessment overview using the tool and the minimum acceptable standards for their level of facility. A team from the PMO's planning office will then visit for the PA, sometimes with representatives of CPs or senior leadership from neighbouring facilities.

The format for the PA is as follows:

1. Review actions arising from previous PA, provide explanation for actions not completed
2. Review the facility/office's performance in all areas using the PA tool, discuss progress and setbacks
3. Planners and others performing the PA physically verify a sample of the information provided in the PA for accuracy
4. Planners and others performing the PA then provide feedback in plenary, highlighting successes and making recommendations for areas of improvement that will be reviewed during next PA

Theoretically, performance assessment and quality improvement are inextricably linked. However the two functions currently reside in different directorates within the MoH and the trickle down effect of this structure results in some coordination challenges. Central level planners indicate that there are plans to make the PA tool electronic in the coming years, which would make it a more powerful tool for data capture and analysis. Currently it is stored in excel format individually for each facility/office.

The standard equipment lists per facility in the tool are not harmonized with the standard equipment lists developed by the MoH. It is recommended these be harmonized in the future. Furthermore, the standard equipment lists in the PA tool, while providing a good starting benchmark, do not adequately identify or quantify equipment needs based on services being provided in a facility.

For example, there is a single list of laboratory equipment required, as opposed to a list per area within the lab and the list only indicates that one of each device, such as a centrifuge, is required.

Therefore a facility may score 100% on equipment availability in a particular area but not actually have the necessary equipment to perform all of the functions within that area. This type of data may mask larger equipment availability challenges.

One further recommendation for the PA tool is to review and update the specific metrics related to medical equipment, with the possibility of differentiating them by level. It is appreciated that each area within the tool can only have a short list of metrics, but these can be changed to capture more level-specific indicators of equipment services.

For example, the presence of preventive maintenance at a level 3 hospital is quite a good indicator of service provision, but at a health post or rural health centre routine visits from a trained BMET would provide a more context-appropriate indication of medical equipment service provision. Furthermore, the yes/no nature of the response misses the opportunity for more rich detail, such as the percentage of equipment within a facility that undergoes routine preventive maintenance.

Therefore, it is recommended that HTM service provision indicators be facility level specific, and changed from binary data (yes/no) to percentage data where appropriate.

The current tool is included in the supporting documentation.

3.1.4 Quality improvement

The Directorate of Clinical Care and Diagnostic Services (DCCDS) oversees the MoH's quality improvement (QI) function. A national QI guideline has been drafted in order to:

- Harmonize QI approaches in use in the health sector
- Develop a common understanding of quality of care among health providers
- Systematically elaborate QI approaches that should be utilized in all health facilities in Zambia by managers and staff at all levels
- Establish standards against which all health facilities can provide quality health care across all levels
- Provide the basis upon which service delivery can be assessed, gaps identified and strengths appraised in collaboration with all stakeholders including the community

This guideline and a series of draft service quality assessment (SQA) tools are discussed in more detail in [Section 9.2](#). The draft QI guideline is included in the supporting documentation.

3.2 HUMAN RESOURCE PLANNING AND BUDGETING

3.2.1 National human resources for health strategic plan (NHRHSP)

The national HRH strategic plan (NHRHSP) outlines the MoH's strategic plan for health workers, aligned with the health sector priorities identified in the NHSP. Similarly to the NHSP, the 2011-2015 NHRHSP was extended by one year and drafting is currently underway for the 2017-2021 NHRHSP.

The plan provides a detailed situation analysis of HRH within the Zambian health system, outlines priorities, proposed strategies and expected results from HRH interventions. The current plan does not specify medical equipment personnel such as BMETs as a cadre of health worker. It is assumed they are either included in either the 'support staff' or the 'craft and trade staff' category.

The HRHSP for 2017-2021 is currently being drafted and it is of *utmost importance* that medical equipment personnel are included in the plan. They are the custodians of very expensive equipment investments and crucial to effective service delivery within the country. Discussions with human resource staff within the MoH indicate that the most senior leadership levels within the MoH drive the changes made to the cadres included within the plan.

It is highly recommended that medical equipment personnel be included in the 2017-2021 HRHSP plan.

The two most recent NHRHSPs are included in the supporting documentation.

3.2.2 Post establishment and assignment

The establishment is a list of every approved position within the MoH staffing structure by job title and location. It includes positions that are frozen, i.e. have no funding allocated to them, and those that are filled or being filled. It was unfortunately not possible to gain access to a copy of the establishment during the mapping exercise, however a copy should be obtained for any human resource planning activities for medical equipment personnel.

The staff assignment provides an overview of the percentage of establishment posts that are filled, unfilled and frozen. Provincial human resources (HR) staff periodically collate this information for a province wide overview of staffing needs. It was not possible to gain access to a copy of a sample staff assignment during the mapping either, but these should most certainly be obtained for any future human resource planning for medical equipment personnel.

The CMEO prepared a staffing proposal for medical equipment personnel at each level of the health system in Q3 2016. The full proposal is presented in [APPENDIX H](#). It requires endorsement from the Permanent Secretary (PS) for inclusion in the revision to the establishment. More detail about this process is provided in [Section 5.8](#).

3.2.3 Staffing prototypes

The staffing prototypes specify the type and number of health workers that should be allocated to each level of health facility. For example, there is a staffing structure for a L1 hospital, an L2 hospital, etc. It was unfortunately not possible to gain access to the staffing prototypes during the mapping and it is therefore not known whether medical equipment personnel are listed in the prototypes as a distinct category of staff or if so, whether their allocation per type of facility aligns with the proposed staffing structure developed by the CMEO. This should be investigated further for any human resource planning activities for medical equipment personnel.

3.2.4 Planning and budgeting tool for facilities

During meetings with provincial and central level HR staff, it was also noted that a guide for facilities to plan and budget for the unfreezing of posts and creating of new posts exists. Again, it was not possible to obtain this tool during the mapping but it is recommended that it be used for any human resource planning for medical equipment personnel going forward.

3.3 PLANNING AND BUDGETING FOR MEDICAL EQUIPMENT

Several planning and budgeting tools exist specifically for medical equipment, although some have not been disseminated effectively. Many of these tools were developed through the support of the Japanese International Cooperation Agency (JICA)'s Health Capital Investment Support Project between 2010 and 2016. It must also be noted that much of the guidance in the resources, however good, faces barriers to implementation at the facility level due to resource constraints, including human resources, and HTM practices not being prioritized.

3.3.1 Medical equipment management guidelines

These are the national guidelines for medical equipment management within MoH facilities in Zambia. They include guidance on:

- How to receive donations to the MoH and facilities
- How to receive new equipment to the MoH and facilities
- How to establish an equipment management committee at provincial, district and facility levels
- What level of medical equipment professional should be employed at district, L1, L2 and L3 level hospital level, and example job descriptions for each
- How to set up a medical equipment maintenance and management system
- How to manage equipment consumables and spare parts
- How to set up and resource a biomedical engineering workshop
- How to perform an inventory and analyze inventory information for planning purposes
- How to develop an equipment development plan to prioritize equipment acquisition
- How to plan for and perform user, corrective and preventive maintenance

The guidelines include sample forms for all stages of the equipment life cycle, from acceptance to decommissioning. Daily user maintenance and generic (i.e. not model specific) preventive maintenance instructions are also provided for the devices included in Table 4 in the form of single page forms that can be printed off and used directly in a facility.

Table 4: Devices for which daily user and generic preventive maintenance procedures are provided in guidelines

1. Water bath	10. Dental unit	19. Electrosurgical unit
2. Water distiller	11. Microscope	20. Automatic X-ray film developer
3. Hematocrit centrifuge	12. Suction unit	

4. Centrifuge	13. Blood pressure machine	21. X-ray, mobile
5. Incubator/Drying oven	14. Operation table	22. X-ray, fixed
6. Autoclave	15. Operation light, mobile	23. Solar system
7. Autoclave, vertical	16. Oxygen concentrator	24. Fetal doppler
8. Refrigerator	17. Patient monitor	25. Pulse oximeter
9. Infant incubator	18. Anesthesia apparatus	26. Ultrasound diagnostic equipment

Dissemination sessions and training have taken place on the medical equipment management guidelines but there could be much more uptake and implementation of the tools contained therein. These should be evaluated for use in future quality improvement projects to avoid 'reinventing the wheel'.

The user maintenance and generic preventive maintenance forms could also form the basis for future capacity building and training sessions for medical equipment personnel. It is recommended that the guidelines form the basis of future service improvement, training and capacity building work.

The medical equipment management guidelines are included in the supporting documentation.

3.3.2 Standard equipment lists

The MoH has developed standard equipment lists for all levels of healthcare facility except tertiary facilities, which by their nature have very specific, specialized equipment requirements. These standard equipment lists include:

- Medical equipment for a health post (2006)
- Medical equipment for a rural health centre (RHC) and an urban health centre (UHC) (2006)
- Medical equipment for a level 1 hospital (updated in 2008)
- Medical equipment for a level 2 hospital (2012)
- Medical equipment for a level 3 hospital (2012)

It should be noted that these lists are not harmonized with the PA equipment standards lists; they are more extensive. These lists form the basis of the equipment packages procured by the MoH in bulk to equip lower-level health facilities (more on this later). Based on their very nature, i.e. that they are standard lists, they won't perfectly prescribe what is required in every facility, particularly higher level facilities with more variation in services, but they do provide a good baseline for equipment planning.

The health post, RHC/UHC and L1 hospital lists are included in the medical equipment management guidelines in the inventory section. The distinct L2 and L3 lists, which include tool and test

equipment requirements for a biomedical engineering department, are both including the supporting documentation.

3.3.3 Standard manufacturers and models for medical equipment

In April 2016, the DCCDS circulated a list of standard makes and models for the following types of medical equipment that should be procured by CPs, the MoH itself and any other organization wishing to procure equipment on the MoH's behalf. Each device lists several preferred makes and models that should become standards, based on the capacity to maintain the devices in-country.

Standardisation also enables simpler spare part procurement and presents a lower training bar for users and maintenance personnel alike. The standardization proposal is currently with the Zambia Public Procurement Authority (ZPPA) for their feedback. If adopted and adhered to, it will represent a significant achievement in working towards improved HTM practices in country. The proposed list of twenty-one devices / equipment sets is presented in [APPENDIX I](#).

3.3.4 Guidebook for budget allocation for periodic preventive maintenance of medical equipment and infrastructure

This guidebook was published in early 2016 as one of the final project outputs of the HCISP project. It provides guidance on budgeting for preventive maintenance for medical equipment targeted at district health offices and district (L1) hospitals.

It is designed to provide budgeting guidance for maintenance requirements that can feed in to the district's budgeting component of the action planning process between approximately May and August each year. It includes the inventory template and standard equipment lists for district level facilities.

The guidebook can be requested in soft copy from the CMEO or JICA program staff; it was only provided during the mapping exercise in hard copy and therefore is not included in the supporting documentation.

3.3.5 Guidelines on donations of equipment to Ministry of Health

These guidelines were developed originally in 2002 for medical equipment donations. They are based on WHO guidance and include the responsibilities of both the donor and the recipient (the MoH and/or its health facilities) to ensure donations are appropriate. This includes planning for spare parts procurement, supplying user and maintenance manuals, ensuring local technical knowledge for the donated equipment.

While these guidelines exist, much work must be done to encourage and empower recipient facilities to clearly communicate what they do and don't want from donors and to ensure their medical equipment personnel are engaged for technical inputs when the donation is first being negotiated. A large power differential can exist, and leadership within recipient facilities that are in dire need of new equipment are often very reticent to ever say no to a donation, whether solicited or not, or useful or not, for fear the next donation may go elsewhere.

Further guidance, published by THET, is provided in [Making It Work: a toolkit for medical equipment donations](#). The toolkit provides practical guidance for both donors and recipients based on WHO guidance and national guidelines such as the Zambian guideline. While behaviour change related to donations can be a challenge, the toolkit can be used for advocacy within facilities and between facilities and donors to encourage better practice. The toolkit is included in the supporting documentation.

The full national guideline is included as an annex to the medical equipment management guidelines.

3.3.6 Guidelines on receiving new equipment and equipment donations

These guidelines, also developed in 2002, provide facilities with guidance on proper acceptance and commissioning procedures for medical equipment. They have been integrated into the guidance and forms developed in the medical equipment management guidelines. The full guideline is included as an annex to the medical equipment management guidelines.

3.4 PROCUREMENT OF NEW MEDICAL EQUIPMENT

Procurement of new equipment at the central and the facility level follows procurement procedures that include their own documentation. These are presented in more detail in [Section 5.1](#).

3.5 INSTALLATION AND COMMISSIONING OF MEDICAL EQUIPMENT

The installation and commissioning of medical equipment also follows specific procedures and includes specific documentation depending on how the equipment is procured and by whom (i.e. the MoH, a CP, etc.). Again, these are presented in more detail in [Section 5.3](#).

3.6 MAINTENANCE AND MANAGEMENT OF MEDICAL EQUIPMENT

In addition to the guidance provided in the management guideline, provinces and facilities are being encouraged to use the standard inventory template included in guideline. The template is provided as a stand-alone tool in the supporting documentation. Guidance for filling it in is found in the guidelines.

3.7 TRAINING FOR MEDICAL EQUIPMENT PERSONNEL

Some training materials exist that have been developed specifically for equipment users and maintenance staff within Zambia. These have generally been developed with the support of a particular cooperating partner, either for new equipment being supplied or as part of a specific short medical equipment course. Examples of these training materials include:

- Training materials from the Kitwe-Ndola hospital management (KANDO) project, supported by DfID, which ran from 1995-1998 and focused on the three L3 hospitals in the Copperbelt (Ndola Central Hospital, Kitwe Central Hospital and Arthur Davison Childrens Hospital).
- Training materials from the Ontwikkelings Relevant Export Transakie (ORET) project that supplied imaging, theatre and monitoring equipment and ended in 2009 with support from the Dutch cooperation agency.
- Technical information materials developed by Crown Agents, the procurement agent for DfID's Emergency Obstetrics and Neonatal Care (EmONC) project, to provide maintenance personnel with knowledge of the equipment supplied through the project. The materials are included in the individual 'equipment maintenance reports' for each type of equipment supplied (incubators, anesthetic machines, autoclaves, suction machines, oxygen analyzers, operating tables and examination lights).
- Training materials developed for JICA's HCISP project, in the form of a textbook written to provide technical training to maintenance personnel on the twenty-six priority devices listed in Table 3. The textbook covers principles of operation, device components, common faults, basic daily user maintenance and generic PM procedures for the devices.

The training materials from the KANDO and ORET projects have not been found in either hard or soft copy. However; the training materials do exist in soft copy for both the HCISP textbook and the equipment maintenance reports for the EmONC equipment. The latter in particular should be shared with maintenance staff as they are excellent technical resources but have not been disseminated effectively, as was noted in a 2012 independent audit of the project's equipment supply activities.

The NORTEC BMET students also have access to very good quality training materials through their course of study at the college. In addition to these resources, additional training resources that may be of use for future capacity building and training exercises are included in [APPENDIX I](#). The KANDO textbook, EmONC equipment maintenance reports, and independent audit report are all included in the supporting documentation.

3.8 DECOMMISSIONING AND DISPOSAL

The formal decommissioning and disposal process for all MoH assets, including medical equipment, is governed by the Property Survey Board (PSB) and has specific documentation requirements. These forms are discussed in more detail in [Section 5.5](#).

4 FINDINGS

The key findings from the mapping that relate to the processes at central, provincial, facility and district level are presented in this section. These findings are presented for the various phases of the medical equipment life cycle. Particular attention was paid during interviews to the processes related to planning and budgeting, procurement and equipment maintenance and management systems. For each set of finds, key strengths and challenges are presented, as are recommendations for improvements in the area.

4.1 PLANNING AND BUDGETING FOR NEW EQUIPMENT

4.1.1 Central level - current picture

Overview of planning process

- Using the national health strategic plan, procurement priorities for the year are outlined in MoH action plan
- These priorities are generated by CMEO in consultation with leads from other areas (medical imaging, laboratory, nuclear medicine, paediatrics, etc.) and approved by Director CC&DS; they tend to 'roll over' from previous years either because they are part of a multi-year procurement plan or because they were not funded in previous years
- Their focus is on large capital items (CT scanners, dialysis machines, etc.) and equipment bundles for turnkey tenders to build and equip new facilities (health posts, health centres, L1 hospitals)
- They are translated into the MoH's capital medical equipment procurement plan, including budget requirements per line item
- CPs are also engaged in this process when they are providing support to the procurement plan and when they are planning procurement activities specifically for their programs (for example, when they procure emergency obstetric care equipment for their program work)

Overview of budgeting process

- Within the national action planning framework, the MoH receives budget guidelines from the MoF that provide an indication of the following year's budget ceiling
- The MoH then allocates this overall budget ceiling to its directorates and units so that they have budget guidelines also to use to prepare their draft action plans for the following year
- Part of the planning process includes a review of the past three years of activities (for example, that 20%, 30% and 50% of the CT scanner procurement target was met in 2014, 2015 and 2016 respectively due primarily to funding gaps)
- With this indicative budget allocation, the CMEO identifies the financial gaps for the new procurement plan (for example, the 2017 allocation for new equipment is KW 46,355,037,

while the budget required for the procurement plan is KW 99,000,000) and approaches CPs to help fill the financial gaps (in this case, the KW 52,644,963 deficit)

- Some items in the procurement plan have funding sources other than a GRZ grant (for example, the procurement of equipment bundles for L1 hospitals is funded through a line of credit from the Indian government with the requirement that all suppliers be Indian)
- The funding allocation per activity outlined in the MoH action plan is finalized in Q4 for the following year when the 'yellow book' is presented to Parliament
- The yellow book includes a budget line specifically for the procurement of new medical equipment, however the full budget allocation is not always released by the Treasury (for example, just under 20% of the 2016 budget allocation for all medical equipment unit activities, including equipment procurement, was released)
- When funding gaps persist but equipment procurement is prioritized, funding is sometimes re-allocated within the MoH to meet the financial gaps

4.1.2 Central level – findings

Key strengths for planning and budgeting

- Planning processes within the MoH are firmly established and well managed
- The development of the medical equipment procurement plan engages a wide variety of central-level stakeholders, including other unit leads and CPs
- The centralized planning of medical equipment within the medical equipment unit is more efficient than a decentralized planning and procurement process across different units
- Similarly, the decentralized planning and budgeting for equipment consumables and quality assurance (QA) materials to different units such as laboratory and medical imaging is also an efficient model
- For laboratory equipment, service contract costs are rolled into consumables costs and as a result generally well funded (and managed)

Key challenges for planning and budgeting

- Funding is severely constrained and not adequate to fully cover any of the activities
- Maintenance and other life cycle costs are not planned or budgeted for when new equipment is procured (for example, service contract procurement is not linked to capital equipment procurement)
- Within this severely constrained budget, there is an overemphasis on procuring new equipment at the expense of funding maintenance activities and service contracts (for example, new procurement represented 91% of the 2016 budget allocation, with service contracts being allocated just 8% of the budget and no budget being allocated at all to technical support meetings for the MoH medical equipment maintenance personnel, such as annual meetings for the PMEOs with the CMEO to disseminate new technical guidance, receive training on specific devices, etc.)

- The provision of service contracts tends to be for equipment that has already been installed, meaning the MoH has less bargaining power when negotiating the contracts; similarly, they are for a one year period which also limits ~~both~~ the bargaining power, increases the cost and often results in more gaps between service coverage also a the
- Communication between facilities and the centre is a challenge (for example, facilities report that their requests for priority equipment procurement to the MoH are not reflected in the procurement plans, while the central level lacks the capacity to manage the large volume of requests it receives)
- Some programmatic areas receive a relative oversupply of equipment from CPs while other areas of general equipment are in critically short supply (for example, lots of equipment for maternal and newborn health, HIV diagnostic services, etc. is sent to facilities that may not have any basic equipment such as oxygen concentrators for their medical inpatient wards)
- Even at the central level, many offers are made for equipment donations which can be challenging and time consuming to oversee and manage

4.1.3 Central level – recommendations

- Combine the procurement of new equipment and service contracts and extend the length of service contracts past one year to 3-5 years
- Include maintenance requirements in initial procurement, such as first line troubleshooting training for ~~x~~ a minimum number of MoH staff (such as five), full parts list with manufacturer's item code, etc.

4.1.4 Provincial level – current picture

- PMOs do not procure new medical equipment, but the PME0 does act as the communication link between the MoH and facilities for planning and budgeting; therefore, the annual draft MoH action plan's medical equipment activities are shared with PMOs so they can develop their plans around them and communicate them also to the facilities
- PMO action plans include medical equipment activities undertaken by the PME0 mainly focusing on new equipment installation, training and maintenance activities
- The Copperbelt PMO also occasionally funds equipment delivery to provincial facilities, and spare parts requests from facilities that they can not meet themselves but this is an infrequent occurrence and not planned or budgeted for in advance

4.1.5 Provincial level – findings

The findings are limited as the province does not plan or budget for new equipment.

Key strengths for planning and budgeting

- Strong communication between the CME0 and Copperbelt PME0 about procurement plans that drive equipment installation and training
- The Copperbelt PME0 has a good overview of the provincial facilities' most urgent needs and issues relating to medical equipment, mainly from installation and maintenance visits

- The Copperbelt PMO delivered an HTM workshop to mixed stakeholders from facilities in 2012 and many of the concepts covered at the workshop were evident during facility visits

Key challenges for planning and budgeting

- Severely constrained budgets (for example, the Copperbelt PMO's budget for medical equipment activities fell from KW 22,000 monthly in 2015 to KW 9,000 monthly in 2016)
- PMEo doesn't get current and accurate information about equipment needs from all facilities in the province

4.1.6 Provincial level – recommendations

The recommendations are limited as the province does not plan or budget for new equipment.

- Help disseminate planning and budgeting tools and information to facilities, preferably through a capacity building workshop with a mixed group of stakeholders from each facility

4.1.7 L3/L2 facility level – current picture

Overview of planning process

- Medical equipment requirements are listed in the hospital's action plan; the list is generally very extensive, from large capital equipment such as ultrasound machines to small equipment such as BP machines and thermometers
- Gantt chart activity plan includes procurement plan for all equipment in the list; however most items on the list, particularly the larger items, go unfunded and are not procured
- The procurement activities are reviewed twice annually during the PA exercise and also during the preparation of the next year's action plan
- On a monthly basis, facilities procure small devices themselves (BP machines, glucometers, infant scales, etc.) with funds from their monthly GRZ grant; the availability of these funds depends on the urgency of competing priorities within the hospital, such as drugs shortages
- Departments submit their equipment requests (some monthly/quarterly and some on an ad hoc basis, particularly at smaller facilities) through a senior nursing or clinical officer to the management / finance committee that allocates the monthly grant within the facility
- Often, equipment is prioritized for procurement only when it is urgent, for example to replace a device that has broken down the action plan
- Senior management within facilities write regularly to the MoH for large equipment needs, such as maintenance or replacement of an x-ray system or an ultrasound probe
- Senior management within facilities regularly solicit support from partners for funding for the equipment on the list and for donations of used equipment that may be of use

Overview of budgeting process

- Same as at central level, facilities do not include maintenance and other life cycle costs in the cost estimate for new equipment

- Facilities make cost estimates for new equipment based on what they have paid in the past for similar, and use other sources of information (such as the internet) when needed
- Most facilities are only authorized to procure items that cost less than KW 50,000 themselves because they don't have a procurement committee that meets ZPPA standards (Kitwe Central Hospital is an exception)
- Funding rules require hospitals to spend their full grant every month, therefore they can't set aside a small amount of their grant every month to procure something more costly
- Facilities routinely lobby the MoH and partners for funding support for equipment needs

4.1.8 L3/L2 facility level – findings

Key strengths for planning and budgeting

- Facilities are very aware of what their equipment needs are, from senior management down to lower level clinical staff and maintenance personnel
- The planning processes equipment planning and budgeting sit within are well established and managed
- The comprehensive list each facility includes in their action plan is a good advocacy tool for soliciting support from partners
- The action planning process and PA process both provide lots of opportunity to highlight funding gaps for equipment constrain procurement and the negative effective out of service equipment has on service delivery

Key challenges for planning and budgeting

- Budgeting for new equipment doesn't include maintenance or life cycle costs
- There is no dedicated budget line for medical equipment procurement at hospital level
- There is a significant emphasis imbalance between the purchase of new equipment and maintenance costs; maintenance budgets should be much higher relatively than they are
- While needs are well known at facility level, technical information about equipment options is often lacking
- Equipment donations from smaller donors can be difficult to use and maintain, but facilities have such acute equipment needs they are highly unlikely to ever reject a donation offer
- Departmental monthly budgets are often re-allocated to other areas of the hospital to meet urgent needs; users aren't able to 'own' their departmental budgets for new equipment
- The equipment list is seen as opportunity to communicate/reiterate how much equipment the facility needs and the expectation is not that it will be fully realized; it is used as an advocacy and communication tool to highlight challenges and solicit support
- Funding is incredibly constrained and hospitals are generally 'firefighting' with their grant each month; often this is spent on drugs and food for patients and no funding remains for equipment unless either a new item or a maintenance item is absolutely urgent

- Most facilities are constrained to procuring items that cost less than KW 50,000 and can't roll over funding from month to month
- Most items on the list, particularly the larger items, go unfunded from year to year and are included in the action plan on a rolling basis
- Facilities don't always know what equipment the central-level is planning for them
- Equipment planning isn't harmonized between facilities, the MoH and CPs

4.1.9 L3/L2 facility level – recommendations

- Budget for maintenance along with initial equipment procurement
- Always engage the medical equipment personnel while planning for new equipment
- Plan to procure maintenance materials along with new equipment
- Use the standard equipment lists to assess
- Continue to advocate for increased support for equipment
- Seek pooled information about equipment costs from PMO and other facilities

4.1.10 District level – current picture

Overview of planning and budgeting process

- Procurement priorities outlined in district action plan
- Most equipment received through MoH procurement and project equipment from CPs
- Similar to L3/L2 hospitals, funding not adequate to meet requirements
- Very little knowledge about what is expected

4.1.11 District level – findings

Key strengths for planning and budgeting

- Action planning process well understood and managed
- Lots of new equipment being supplied through CPs

Key challenges for planning and budgeting

- Communication between facilities and district office about equipment is sometimes ad hoc, as is communication to facilities and district offices 'downstream' from PMO and CPs; as a result facilities don't tend to know what they will be receiving and when
- District offices don't tend to have inventory overview of what is at facilities
- Many lower level facilities being built, but equipment planning and supply has not caught up
- Budgeting for maintenance in action plans is very low and in some instances zero

4.1.12 District level – recommendations

- Request support from CPs supplying equipment to support maintenance capacity in the district, for example supporting an internship at an L1 hospital to maintain the equipment

4.2 PROCUREMENT OF NEW EQUIPMENT

4.2.1 Central level - current picture

Overview of procurement process

- Specifications are drafted by the CMEO in consultation with lead user(s), who are typically the relevant unit leads from within the MoH but can be staff from specialized facilities also
- The MoH's standard procurement process is then followed; this process is led by the procurement unit and governed by the Zambia Public Procurement Authority (ZPPA)
- When a CP provides direct budgetary support for a specific procurement exercise, they disburse the funds and then audit the MoH's process but do not contribute directly to it; the level of auditing involvement depends on the actual partner
- The tender process is governed by the anticipated value of the tender:
 1. Simplified bidding process for tenders less than ZMW 500,000: procurement officer solicits three quotations and providing all are technically acceptable, the least expensive of the three is selected
 2. National bidding process for tenders between ZMW 500,000 and ZMW 5 million: tender is advertised for four weeks on the MoH website and in print media
 3. International bidding process for tenders over ZMW 5 million: tender is advertised for six weeks on the MoH website and in print media
- Once the bids received have been validated, the CMEO and lead user(s) evaluate the valid offers for technical conformance to specifications, then the procurement unit evaluates the financial compliance to the offer
- The procurement unit then prepares a report, with input from the CMEO, for the procurement committee, which is chaired by the PS and includes all MoH directors and four external members (one private sector procurement specialist, one religious representative, one Transparency International representative and one drug enforcement agency representative) who each sit for three year terms on the committee
- The report may include a recommendation to award the contract to a bidder other than the least expensive, for example a bidder whose equipment is already used extensively in MoH facilities or who has a local service agent Zambia; in these cases a detailed justification must be provided and the committee may either accept the recommendation outright, deny it outright and award to the least expensive technically acceptable bidder, or direct the CMEO to solicit funds for the cost difference from within the DCCDS
- Once a bidder has been selected, all bidders are notified and have ten days to ask questions and receive responses on the tender and then the draft award contract is sent to the Ministry of Justice (MoJ) to review the legalities
- Once the MoJ has approved the contract, it can be signed by both parties and then pre-delivery activities, such as a pre-shipment inspection by the CMEO and lead user(s) to verify what will be received, can commence

4.2.2 Central level – findings

Key strengths for procurement

- The procurement process is very clearly defined and communication and coordination between the CMEO and the procurement unit for tenders appears to be very effective
- Tender documents specify supply, delivery, installation and commissioning of new equipment
- There is a large amount of flexibility within the specifications that could be harnessed to include non-capital items with each device, such as maintenance manuals and materials
- The recently drafted preferred makes and models list for new medical equipment represents a significant opportunity to increase the standardization of equipment being procured, which will facilitate better maintenance

Key challenges for procurement

- In the absence of a strong national regulatory authority for medical equipment in Zambia, equipment supplied on the local market can be of very poor quality; this places an unduly large responsibility on the CMEO and lead users drafting the specifications to ensure they discourage poor quality offers by writing particular technical requirements directly into the specifications, which are difficult to confirm during the technical review of offers
- The MoH's modernization program requires the CMEO to draft specifications for increasingly complex devices, with very little access to experts on these technologies
- CPs are increasingly supporting the MoH through direct budgetary support for medical equipment procurement as opposed to using their own procurement channels; while this represents confidence in the MoH's process, it also means an increasing procurement workload for the CMEO without additional resources to do the work
- The description and specification of activities such as 'installation' and 'commissioning' in tender documents is not always specified in detail, leaving room for suppliers to deliver sub-standard services in the area

4.2.3 Central level – recommendations

- Increase the capacity within the medical equipment unit for procurement work to a higher level based on the volume of procurement related technical activities such as specifications development and technical evaluations of bids
- Combine the procurement of new equipment with the procurement of service contracts for that equipment
- Request support for additional procurement capacity from CPs who provide financial support for new equipment procurement
- Include specific maintenance-related requirements directly into the specifications, including:
 - Most commonly changed basic spare parts for a two-year period for each device

- Maintenance as well as user manuals for each device (level of maintenance manual will depend on the complexity of equipment and whether the MoH maintenance personnel will be doing all maintenance on it or only first line troubleshooting)
- Full list of spare parts for the device with manufacturer's item codes
- Include specific training requirements directly into the specifications, including:
 - Training for users specified by length of training and training method
 - Training for maintenance staff specified by level of training (i.e. first line maintenance and troubleshooting, full field service engineer (FSE) level, etc.)

4.2.4 Provincial level – current picture

- PMOs do not procure new medical equipment, but the PME0 does act as the communication link between the MoH and facilities regarding what is being procured for them, what general timeframe they can expect for installation, etc.

4.2.5 Provincial level – findings

The findings are limited, as the province does not procure new equipment.

Key strengths for procurement

- PME0 has a good overview of the MoH's procurement plans for Copperbelt facilities, including the anticipated delivery schedules and the suppliers who will perform installations

Key challenges for procurement

- Communication with facilities and districts that will receive centrally-procured equipment is often ad hoc due to the volume of requests being made to the PMO for medical equipment maintenance support, information etc.; as a result facilities often don't know when they will receive equipment and can't plan properly for it, or don't know what level of service they should be contractually entitled to and therefore sign off on sub-standard services (for example, signing off on a goods received note from the supplier for 'delivery, installation, commissioning and training' when training was inadequate, records for commissioning were not produced, etc.)

4.2.6 Provincial level – recommendations

The recommendations are limited, as the province does not procure new equipment.

- PME0 should be supported to deliver further HTM training to Copperbelt facilities and districts that includes guidance on what receiving facilities should expect in terms of services for centrally-procured equipment

4.2.7 L3/L2 facility level – current picture

Overview of procurement process

- Medical equipment priorities are listed in the hospital's action plan but funds to procure are generally lacking
- When equipment is procured, either as part of a planned activity or in an emergency to replace an item that isn't functional, local tendering is done using the simplified bidding process – soliciting three quotations from local suppliers
- At larger facilities, such as the two L3 hospitals, it is often the medical equipment personnel who solicit these quotations from local vendors
- A specific make and model is requested when desired, for standardization within the facility or if it is known to be of good quality; specifications are usually very brief (for example, 'one oxygen concentrator, manufacturer X, model Y') and generally do not include spares or other maintenance materials such as service manuals
- Hospitals aren't able to procure internationally due to procurement rules and are therefore dependent on local traders, most of whom are not official distributors for equipment manufacturers and therefore have very limited to no technical knowledge on the equipment
- The supply chain as a result is also one step longer (i.e. trader – distributor – manufacturer) which lengthens the turnaround time and increases the price; basically the trader is being paid high prices for it's ability to import the equipment into the country
- When a generic item (i.e. 'one oxygen concentrator') is specified, the medical equipment personnel / user from department may recommend a quote that is not the least expensive if it can be justified for reasons of standardization, high quality, etc.
- The typical high-level process for procurement is:
 - Request is made by high level user from department
 - Management / finance committee approves the procurement of item(s) in principal
 - Medical equipment personnel / procurement officer / user from department solicits three quotes from local suppliers for item(s)
 - Medical equipment personnel / procurement officer / user from department prepares report with justification for purchase, three quotations and recommended supplier
 - Report is taken to senior management (such as senior medical superintendent for L3 hospitals) for approval, then order is placed
 - When item is received in country, payment is made (sometimes with a percentage of payment made up front) and goods are then released to the facility
- Wait times vary but often facilities wait 2-4 months for internationally sourced equipment
- Sometimes item received is not to specification and it can be difficult for facility to demand recourse if the item has been delivered and accepted by stores

4.2.8 L3/L2 facility level – findings

Key strengths for procurement

- Flexibility in procurement process allows for specification of high quality equipment, and would allow procurement of spare parts, service manuals, etc. along with equipment
- Very clear, well understood procurement processes in place in all facilities

- Significant involvement of medical equipment personnel in process at larger facilities
- Ability to specify exact make and model the users and maintenance staff are familiar with

Key challenges for procurement

- Inability to procure equipment internationally results in higher costs and lengthy delays
- Relative lack of official distributors in-country / locally results in poor information being available, higher costs and more lengthy delays due to longer supply chain
- Lack of a functional regulatory authority in country for medical devices results in very low quality and sometimes counterfeit equipment being sold on the local market, which is a significant patient safety concern as well as a procurement challenge
- Funds are sometimes reallocated within a facility between when the order is placed and the item arrives and payment is expected
- Many facilities noted procurement challenges during the workshop, including knowledge and capacity of procurement staff with respect to medical equipment procurement and how it differs from other types of procurement

4.2.9 L3/L2 facility level – recommendations

- Spare parts should always be procured with new equipment when they are likely to be required, as should technical troubleshooting manuals
- Always ensure medical equipment personnel / users from department sign off on item(s) received to ensure they conform to specification
- Where possible, facilities should try to pool procurement to get lower prices from local suppliers and share pricing information amongst themselves
- Use existing procurement specifications online to improve facility level specs and technical knowledge (links to publicly available specifications in [APPENDIX K](#))
- Create opportunities for medical equipment personnel and procurement personnel to learn from one another with respect to procurement requirements

4.2.10 District level – current picture

Overview of procurement process

- District action plans include procurement activities for medical equipment, but similar to L3/L2 hospitals funding is not adequate and few planned activities take place
- The plans do not generally specify what equipment is needed, a generic ‘purchase medical equipment’ activity is included in the plan
- L1 hospitals, health centers and health posts within a district receive the vast majority of their equipment through the MoH (bulk tenders for facilities) and CPs (implementing programs close to the community level)
- For minor devices that are urgently required, facilities often request funds from the district office but do not always receive funding

- Facilities often report receiving equipment they don't need while needing equipment they don't have

4.2.11 District level – findings

Key strengths of procurement

- Ability to share new equipment supplied by MoH/CPs at a district level
- Lots of new equipment arriving that is standardized (through bulk tenders) that present opportunity to share maintenance knowledge, spare parts, etc.

Key challenges of procurement

- Communication between facilities and district office about equipment is sometimes ad hoc, as is communication to facilities and district offices 'downstream' from PMO and CPs; as a result facilities don't tend to know what they will be receiving and when

4.2.12 District level – recommendations

- Spare parts should always be procured with new equipment when they are likely to be required, as should technical troubleshooting manuals
- Where possible, facilities should try to pool procurement within the district to get lower prices from local suppliers and share pricing information amongst themselves
- Request CPs supplying equipment for program work to also support in-district maintenance capacity

4.3 INSTALLATION AND COMMISSIONING

4.3.1 Central level - current picture

Overview of installation and commissioning process

- Installation and commissioning requirements for devices included in MoH tender documents
- Similarly, CPs who procure their own equipment or use a procurement agent to do so generally include their own specific installation and commissioning requirements
- The CMEO is only involved personally in installation and commissioning work for a small amount of the complex new equipment, such as that procured for Cancer Diseases Hospital
- During a tender, bidders are required to provide documentation of their capacity to install the offered equipment

4.3.2 Central level – findings

Key strengths for installation and commissioning

- Installation and commissioning are always specified in the tender documents
- Installation and commissioning is accurately requested per type of equipment

Key challenges for installation and commissioning

- The terms and conditions for installation and commissioning specified in the tender documents are relatively generic; they do not include device-specific installation and commissioning activities in a 'scope of work' section that outlines who (contractor or client) will be doing what to a very low level of detail
- This leaves the MoH and facilities open to sub-standard installation and commissioning works when the scope of work is not specified and the facilities themselves do not know what they should expect of the contractors
- Similarly, it may leave them open to sub-standard work when they lack the capacity to interpret the terms proposed by the bidder in their submission
- Installation and commissioning records for centrally procured equipment reside with facilities and therefore the medical equipment unit does not have a harmonized overview by supplier/tender/equipment package of the results or quality of the records or the work itself

4.3.3 Central level – recommendations

- Increase the capacity within the medical equipment unit to accurately specify the installation and commissioning terms and to be able to accurately review the installation and commissioning terms proposed by a bidder
- Request support for additional capacity related to this aspect of procurement from partners who support procurement and procurement-specific capacity building

4.3.4 Provincial level – current picture**Overview of installation and commissioning process**

- The PMO coordinates most installation and commissioning activities in the province, serving as the main communication link between facilities and the MoH/CPs who provide equipment to them, as well as the main communication link between suppliers who do installation and commissioning work and the facilities
- The PMO often does the installation and commissioning work himself for the province (in fact the majority of the provincial medical equipment budget is spent on installation and commissioning visits)
- The PMO tends to bring along current NORTEC students and various other BME personnel from within the province to assist with the work and learn while doing it, and to run brief user orientation sessions on the equipment at the same time

4.3.5 Provincial level – findings**Key strengths for installation and commissioning**

- PMEOP has very strong technical skills for installation and commissioning work
- Growing network of BME personnel in province to assist with installation and commissioning work

Key challenges for installation and commissioning

- Installation and commissioning workload in the province is too high to be completed soon after delivery and facilities often face delays getting their new equipment into service
- Communication with facilities and districts that will receive centrally-procured equipment is often ad hoc due to the volume of requests being made to the province and central level
- Similarly, to the challenges with procurement at the provincial level, facilities often don't know when they will receive equipment or what to expect from suppliers for installation and commissioning work and therefore can't plan for it properly; this is a particular challenge for the installation of any equipment that requires infrastructure work, such as water system and piping work for a new sterilizer

4.3.6 Provincial level – recommendations

- Installation and commissioning capacity should be increased through more training for experienced BME professionals in province, alleviating some of the workload at the provincial level
- Spot checks on installation and commissioning work by suppliers should be performed to capture an overview of the quality of work; this should be consolidated and shared with the central level for follow up

4.3.7 L3/L2 facility and district level – current picture**Overview of installation and commissioning process**

- Facilities and district offices generally have very little forewarning for when installation and commissioning will happen

4.3.8 L3/L2 facility and district level – findings**Key strengths for installation and commissioning**

- Lots of expertise at larger facilities for installation and commissioning work
- This expertise is often shared with smaller facilities, which alleviates pressure on the PMEO and enables technical information sharing between facilities in province

Key challenges for installation and commissioning

- Challenges securing budget for transport for installation and commissioning visits from MoH BME personnel, particularly when they come from a different facility as opposed to the province
- Staff not having adequate time to arrange for the right technical staff from the facility (electrician, plumber, etc.) to be present for the work
- Staff not knowing what they should expect during installation and commissioning, for example whether user orientation and training has been performed to a satisfactory standard

4.3.9 L3/L2 facility and district level – recommendations

- Perform training to empower facility staff to understand what they should require from suppliers who perform installation and commissioning work on site
- Review records of work and discuss previous installation and commissioning work by contractors to identify areas for improvement

4.4 USE

4.4.1 User training

User training happens very infrequently. None of the facilities visited had a formal user-training program in place. Most reported that the only training they had received in the past five years was through DFID's EmONC project on maternal and newborn care equipment. User training tends to happen only on an ad hoc basis when a new staff member joins a ward or clinical area. Senior users thought more user training would be very beneficial to raise the knowledge of existing staff. This is an opportunity within facilities for the biomedical engineering personnel.

4.4.2 User maintenance

Similarly, a user maintenance program is not in place at any of the facilities visited for general medical ward equipment, although all did report routine cleaning of equipment with a bleach solution (Jik). Two exceptions to this are senior lab and radiology staff, who tend to run through the necessary QA protocols for their equipment as part of their routine work.

4.4.3 Equipment safety

The lack of functional test and calibration equipment within facilities for their maintenance personnel to use is a serious patient safety issue. Without this equipment, it is not possible to know whether equipment is calibrated and functioning properly. For example, an oxygen concentrator may read that it is delivering 95% oxygen at 2L/min but unless the output can be tested this is not certain.

4.5 DECOMMISSIONING AND DISPOSAL

Equipment is only decommissioned and disposed of at the facility level, however the Board of Survey under the Ministry of Public Works provides oversight and provides and collects the necessary documentation. The provincial and central levels are therefore not involved in this process.

At the facility level, the request to the Board of Survey must come from hospital administration. Environmental Health Technicians (EHTs) and medical equipment personnel both tend to be involved in the process, particularly to provide information about the materials a device contains and its environmental impact.

Several facilities reported that this process was quite onerous and not routinely undertaken. Equipment that could no longer be used tended to pile up on site in a spare space. Obsolete equipment is often kept on site to scavenge for spare parts. Few documented examples of equipment being fully decommissioned and disposed of could be found at the facilities.

Medical equipment can include various types of waste that are hazardous, including electronic, radiological, chemical and biological waste. It is therefore of utmost importance that any disposal program has the capacity to manage these types of waste safely and effectively.

An example of a Board of Survey decommissioning form is provided in the supporting documentation.

4.6 EQUIPMENT MANAGEMENT

Equipment management covers all HTM activities across the equipment life cycle. The involvement of BME personnel in HTM activities within their facilities is presented in [APPENDIX L](#), which covers the main roles and responsibilities, including specific tasks, that are outlined in the job specification for a BMET in Zambia developed during the curriculum development exercise using TEVETA's standard format.

These roles and responsibilities represent the 'gold standard' for HTM activities and tasks a BMET should ideally undertake within their facility. Many of these activities are not feasible in the facilities visited due to severe resource constraints. For example, the maintenance staff are unable to calibrate and test the safety of medical equipment because they unfortunately lack the test equipment required to do so.

Generally speaking, equipment management is constrained within the facilities visited by both a lack of HTM knowledge on the part of both administrators and maintenance staff and a lack of financial resources to implement it. The only exception to this is the private mining hospital, which is much better resourced and has a robust HTM system in place and is ISO 9001 certified.

4.6.1 Planning and budgeting for maintenance

Maintenance budgets within facilities are very low, i.e. generally less than KW 12,000 per month for the largest facilities visited and less for smaller facilities. These budgets are often reallocated and rarely spent on anything other than emergency spare parts.

The HTM policies and practices summary in the supporting documentation provides an overview of the annual maintenance budgets for the facilities visited.

Only one included the procurement of any biomedical engineering resources in their Gantt chart (specifically a biomedical engineering toolbox), but this procurement activity went unfunded. Facilities reported their requests to procure maintenance resources with the budget being denied by senior management, with the funding be reserved only for spare parts procurement.

4.6.2 Inventory

Each facility kept an inventory of sorts, although the information gathered varied and only three facilities visited used the MoH inventory template included in the equipment maintenance and management guideline. At larger facilities, the maintenance personnel kept a medical equipment specific inventory while at some smaller facilities, the administration kept a general inventory for all equipment or used the asset register to provide an overview of the facility's medical equipment.

The PMEEO has a very detailed inventory for the province's three L3 hospitals, three of its four L2 hospitals and two of its L1 hospitals that was developed in 2013. Data for some facilities has been updated as recently as early 2016. The Copperbelt inventory also includes a summary from 2014 of the status of the larger devices in all facilities, which provides rich data on trends with particular devices and required spare parts. For example, four of the five 400L autoclaves supplied in 2012 are not working; three require new printed circuit boards (PCBs) while the fourth requires a new heating element.

Facilities are encouraged to share updated inventories with the PMEEO, who has not had adequate funding in recent years to perform a province wide inventory exercise. The province would benefit significantly from having an up to date inventory that would inform maintenance priorities, spare parts requirements and training needs.

It is recommended that a province wide inventory take place in order to have up to date information with which to determine gaps and requirements.

Specific details about each facility's inventory are presented in the HTM policies and practices summary in the supporting documentation. These inventories are included in the documentation package, as is the provincial inventory.

4.6.3 Equipment management systems

None of the facilities use a software based equipment management system other than the private mining hospital, whose central engineering plant uses a software-based equipment maintenance and management program for mining instrumentation. The hospital's medical equipment is included in this program that views the hospital as just another area with the mine's operation that includes instrumentation that needs to be maintained.

4.6.4 Service contract management

Service contracts are in place for some of the more complex devices in the health system, though not all. The central level procures the contracts for equipment and is the main service contract manager within the health service. Serious challenges exist with service contracts; many do not have adequate funding to be put in place, and there have been instances in the past of contracts lapsing due to financial and other issues.

The service contracts for lab equipment are paid for through overhead charges for lab equipment reagents, often but not always by CPs, and this system works very well. Generally speaking, service

engineers for lab analyzers are relatively responsive and have even provided first line troubleshooting training for PMEOs in recent years. This model should be replicated for other service contracts.

The medical equipment unit within the MoH receives weekly and/or monthly reports from service providers who are contracted for maintenance but due to inadequate capacity, this information is not always communicated effectively to the facilities that are due for preventive maintenance visits.

Maintenance contracts are negotiated after equipment procurement, which leads to higher prices and poor terms and conditions. The one-year terms on these contracts further their financial ineffectiveness. It is strongly recommended the contract terms be lengthened to three to five years and included in initial equipment procurement.

4.7 EQUIPMENT MAINTENANCE

A functional and well-resourced engineering workshop is essential to perform equipment maintenance. The equipment workshops at the facilities varied but generally speaking, none were resourced adequately to perform maintenance effectively. [APPENDIX M](#) presents an inventory of biomedical engineering workshop resources available at each facility visited; the standard equipment guidelines were used as a reference.

4.7.1 Training

Most medical equipment personnel within the facilities did not have any formal on the job technical training on the medical equipment they were in charge of; instead they generally learned by doing and through informal mentorship.

4.7.2 Corrective maintenance

Corrective maintenance, or repair work, is one of the core technical responsibilities of a BME service. While all maintenance staff interviewed were involved in repairs, all also reported challenges completing repair requests effectively. None had statistics available on success rates for repairs within their facility. Key organizational factors that limit maintenance personnel's ability to perform corrective maintenance effectively include:

- Lack of training on the device, either generally or specifically for the particular model
- No stock of spare parts, inability to procure the correct parts either due to availability or cost
- No service manual for the device, lack of ability to access technical guidance online
- No test equipment to properly assess the device, inadequate tools to work on the device

The staff at larger hospitals in particular also performed repairs in response to service requests from smaller facilities; typically providing their time and expertise freely provided the requesting facility paid for their transportation and bought any parts resulting from the repair exercise.

The average number of repair requests per month per facility is captured in the HTM policies and practices summary in the supporting documentation. This monthly figure provides a summary of repairs for each facility visited for which data is recorded. It does not include data on repairs performed for other facilities. None of the maintenance personnel interviewed kept detailed records of these service visits. Sample repair request forms are provided in the documentation package.

4.7.3 Preventive maintenance (PMs)

A robust preventive maintenance program is a hallmark of an effective BME service. While all maintenance personnel interviewed understood the importance of preventive maintenance, only the private mining hospital had the financial and material resources allocated to undertake a full PM program on its medical equipment. Some other facilities did have a schedule posted or in place, but lacked the tools, test equipment and parts to undertake routine PMs for their medical devices.

Generally speaking, periodic inspections and some PM tasks appeared to be undertaken more often on specific types of non-medical equipment that fall within the care of BME personnel, such as mortuary and laundry equipment, than on medical equipment itself. Some maintenance personnel did also report that the PME had done PM visits in previous years on infant incubators, resuscitators and other equipment. Service engineers do perform full PMs for devices on service contract, and leave service reports on site.

More information about individual facility's PM programs is provided in the HTM policies and practices summary in the supporting documentation. Some PM schedule examples are provided in the documentation package also.

4.7.4 Work requests and record keeping

The documentation of work requests and record keeping systems varied significantly by facility. Most facilities kept some type of record of repair work, varying from a notebook to specific maintenance work request paperwork. Both L3 hospitals had generic work request forms for all maintenance work requests including electrical, plumbing, carpentry, etc. Reporting at the L2 hospitals varied significantly.

Repair requests were better documented than any inspections or PMs undertaken, although the repair paperwork generally lacked details on the cause of device failure, steps undertaken to rectify the fault, etc. that could be aggregated to provide a richer picture of maintenance requirements within a facility. For example, if the majority of failure causes were due to user error, this would suggest further user training is necessary. Or if fuses were one of the most commonly replaced parts, this could provide justification for procuring a regular stock of certain fuses for the maintenance department.

Kitwe Central Hospital keeps very good repair request records, using a form that they developed after the KANDO project in the mid-1990s. The mining hospital has very good record keeping for all types of maintenance jobs, but the BME team does not manage it. It is part of the mine's overall

equipment maintenance and management system used by the central engineering department, and the BME team gets a print out of all job requests each morning and submits completed forms at the end of each day.

No facilities kept routine statistics on work requests, although this information was generally solicited during preparations for the PA exercise. Sample work request forms from several facilities visited are included in the documentation package.

4.7.5 Spare parts procurement

None of the facilities had an adequate stock of spare parts in place to draw upon for corrective and preventive maintenance work. Each maintenance team confirmed that they place orders for specific parts when required and approved as priority spending by leadership within their facility. Several common themes related to challenges with spare parts procurement arose during the interviews:

- The local supplier base is very limited and generally does not include companies with technical knowledge of medical devices. This introduces more risk into the procurement process and also places further technical onus on the facility's personnel to know the exact part specification they require. Suppliers have also supplied parts different to what was requested.
- Facilities are unable to procure internationally themselves, and therefore rely on local suppliers to source specific parts from an international distributor and import them themselves. This results in much higher prices and further delays in the process, as the supply chain is longer.
- When procurement is approved, it often takes several months for a part to arrive in country. At this point when payment from the facility is requested, it may no longer be available depending on whether the facility is fire-fighting a different emergency, such as a drugs shortage, that can eat up the budget's current allocation.

Knowledge of the small pool of national and regional suppliers is very limited with maintenance personnel; most did not know, for example, that JICA's HCISP project baseline report includes a survey of in-country suppliers nor did they know of the equipment maintenance reports for each device supplied through the DfID EmONC project, which include parts information and supplier contact details.

Generally speaking, the maintenance teams do not have direct contact with manufacturers or their authorized distributors, with the exception of some service engineers who have overseen equipment installations while the maintenance personnel were present. Communication with service engineers is a significant challenge for most maintenance personnel.

Spare parts procurement generally accounts for most, if not all, of the facilities maintenance budgets. More detail about spare parts for each facility is provided in the HTM policies and

practices summary in the supporting documentation. Sample spare parts procurement paperwork for several facilities is included in the documentation package.

4.8 HUMAN RESOURCES FOR MEDICAL EQUIPMENT

4.8.1 Central level

The medical equipment unit is staffed by the CMEO and, as of early 2016, a medical equipment technologist who has been seconded to assist the CMEO but is not part of the official staffing structure. The official responsibilities of the medical equipment unit are to:

1. Facilitate the development and dissemination of guidelines on Medical Equipment acquisition, usage and maintenance.
2. Oversee the national management of hospital equipment and implementation of maintenance systems.
3. Oversee the service needs of health care technology and advise the Ministry of Health on the services and repair of medical equipment in all government hospitals.
4. Develop guidelines on standard equipment lists for all levels of service delivery as well as develop equipment development plans to be used by healthy facilities.
5. Facilitate the timely preparation of budgets for equipment acquisition, maintenance and management based on activity based budgeting.
6. Facilitate guidelines and overseeing the site preparation for hospital equipment installations.

The CMEO is also responsible for planning human resource requirements and recommending staffing structures. The proposed new staffing structure is presented in [APPENDIX H](#). Generally speaking, there are three ways to increase the number of staff in any given cadre:

1. New post is created in establishment
2. Current frozen post is unfrozen
3. Trade-off is made for another post that has funding allocated to it but is not filled

All of these methods are dependent on prioritization and funding within the MoH structure.

4.8.2 Provincial level

The PME0 is the sole medical equipment officer at the Copperbelt PMO. The creation of provincial medical equipment officers in Zambia over the past decade represents a significant investment in improving medical equipment services by the MoH. At the provincial level, the PMO and PME0 have an opportunity to advocate for the unfreezing and creation of new medical equipment posts

within the provincial structure. Ideally the PME0 should also have a medical equipment technologist working at the PMO also to share the workload, particularly until facilities increase their personnel.

The PMO and PME0 specifically are also in a position to propose 'trade offs' for staffing. The suggested time to undertake this exercise is mid year, around June-July, when six months have passed since new positions were created in January and the funding for those that have not been successfully recruited against, for whatever reason, can be re-allocated to other posts within the facility. These requests are not guaranteed to be successful, but a strong evidence base for the request and justification for the importance of placing qualified medical equipment personnel in post will certainly help.

4.8.3 Facility level

The number, job title and qualifications of medical equipment staff interviewed in the Copperbelt facilities varied widely. Establishment posts are not harmonized across level of facility. Table 4 presents the current BME personnel and variances from the establishment per facility visited.

Table 5: Actual BME staffing and variance from establishment in visited facilities

Facility	Current BME personnel	Variance from establishment (difference between establishment and current – i.e. gaps)
Ndola Central Hospital (L3)	1 x Hospital engineer 1x Senior ME technologist 1 x ME technologist	1 x ME technologist 1 x ME technician (training)
Kitwe Central Hospital (L3)	1 x Hospital engineer 1 x ME technologist	1 x Senior ME technologist 6 x ME technologist
Nchanga North GH (L2)	1 x Electrician	1 x Electrician technician
Roan Antelope GH (L2)	1 x Electrician	1 x Hospital engineer
Ronald Ross GH (L2)	1 x Electrician	1 x ME technologist
Malcolm Watson Hospital – Mining (L2)	1 x Medical instrumentation foreman	n/a

Table 6: Existing and proposed BME staffing structure

Submitted structure		
Level	Existing staffing structure *	Proposed staffing structure **
Central level	1 x CMEO	1 x CMEO 1 x Principal ME Officer
L3 facilities	1 x ME Technologist 2 x ME Technician	1 x Principal ME Technologist 1 x Senior ME Technologist 2 x ME Technologist 1 x Senior ME Technician
L2 facilities	1 x ME Technician	1 x Senior ME Technologist 2 x ME Technologist 1 x Senior ME Technician
Further proposed structure		
Level	Existing staffing structure *	Proposed staffing structure
L1 facilities / districts	-	1 x ME Technician (shared)
* Actual existing structures at facilities differ from this and from each other		
** Specific structures for UTH and CDH not presented here as they are not in the Copperbelt, but these are also included in proposal		

Many facilities reported lobbying the MoH in writing for funding for medical equipment posts. They are encouraged to do so, as lobbying at all levels is vitally important to ensure more posts are funded and the first BMET graduates are placed into service effectively to contribute their skills and knowledge to the health system in Zambia.

5 RECOMMENDATIONS FOR IMPROVING HTM AT CENTRAL LEVEL

This section is intended as a list of interventions, identified throughout the report, that the Ministry of Health could put in place immediately to make some fast key gains in the area of HTM.

5.1 SHORT-TERM RECOMMENDATIONS

5.1.1 Management

- Initiate the inventories of all medical equipment at District level, assessing functionality and developing maintenance cost projections in the same way as cold-chain equipment is currently managed.
- Encourage facilities to share current inventories with the PMEO offices, to allow the creation of up-to-date inventories to inform maintenance priorities, spare parts requirements, and training needs.
- Evaluate the usage of available tools within the existent Medical Equipment Management Guidelines. Encourage their uptake and utilise recommendations in the design of future quality improvement work.
- Review and update the current Performance Assessment tool for medical equipment, differentiating them by level of facility
 - E.g. the presence of preventive maintenance schedules at Tertiary Hospitals, or routine visits by a BMET for Health Posts or Rural Health Centres.
 - Consider questions of more detail (e.g. the percentage of equipment currently subject to routine preventive maintenance).

5.1.2 Strategy

- Work to include the expansion of medical equipment maintenance workforce in the 2017-2021 Human Resources for Health Strategic Plan and the National Health Strategic Plan.
- Ensure that facilities can expand their medical equipment maintenance workforce to take on forthcoming graduates in Biomedical Engineering Technology Diploma courses, by being able to unfreeze existing posts or create new ones where necessary, and that they have the tools and knowledge to allow them to do this.

5.2 MID-TERM RECOMMENDATIONS

As well as some immediate recommendations, seven key mid-term recommendations for the MoH in the area of HTM have come out of this mapping. They represent a more significant amount of work than could be feasibly achieved in a one year time period and thus the MoH and THET will need to prioritize what they most urgently require.

Broadly, the recommendations cover the areas of equipment and service contract procurement and management, BME advocacy and work with CPs to build capacity, modernization of central level equipment management systems and enhancing the usefulness of medical equipment indicators in existing MoH planning and assessment tools. Each recommendation is accompanied by a brief rationale, some suggestions for how to approach the work and resources that may be of use.

5.2.1 Medical equipment procurement

Developing procurement specifications for medical equipment is technically complex and time consuming. Well-developed and accurate procurement specifications are even more important to ensure the quality of equipment in an environment that lacks a robust medical device regulatory agency, as is the case in Zambia. Technical evaluations of offers received also require significant time and effort.

These technical inputs to the medical equipment procurement process are growing as the MoH modernizes its equipment and many CPs shift away from their own procurement channels to direct budgetary support for procurement using the MoH's own processes. The CMEO could benefit from additional support for these technical procurement activities.

Several specific terms can be added to procurement specifications for medical equipment that will make downstream maintenance and management easier. The relative flexibility in the procurement process to specify non-capital line items is very advantageous and can for example enable the addition of the following to the procurement terms and requirements:

- Inclusion of service manuals in addition to user manuals, either first line troubleshooting or full service engineer (FSE) level manuals depending on the equipment and type of service contract
- Inclusion of a two-year supply of most commonly changed spare parts per device procured
- Inclusion of a full spare parts list with manufacturer's item codes and descriptions
- Inclusion of a set of test equipment for high-tech equipment

5.2.2 Medical equipment service contract management

Similarly, the negotiation and management of service contracts for medical equipment would benefit from additional technical capacity development at the central level.

Regarding negotiation, currently one of the biggest central level challenges is that procurement of equipment and related service contracts occur separately; this lack of harmonization results in the MoH having very little bargaining power when negotiating service contracts.

Ideally these two activities should be harmonized to enable better terms and pricing. A related challenge is the current one-year term for service contracts, which again limits the MoH's bargaining power and results in more possible gaps in service than a longer contract, such as 3-5 years, would.

Even as the capacity of the MoH BME workforce grows, some more modern and complex equipment (such as automated laboratory analysers, high-tech imaging equipment including CT scanners, radiotherapy and dialysis equipment for example) will always need to be on service contract.

In these cases, the terms of the service contract can be negotiated to include training and certification for MoH staff as 'first line maintenance' staff with a reduced pricing structure for the contract, but a manufacturer-certified engineer will always be required for full servicing.

Regarding service contract management, communication between the central and the provincial and facility levels could be strengthened to empower provincial and facility level personnel to take on more active management of the suppliers and contracts. Currently this generally only happens with senior laboratory staff, who tend to be more engaged with equipment management due to the nature of their interaction with the analyzers in their care.

Improved communication and data collection from facilities could also empower the central level with the information required to hold suppliers to account, such as service request turn around times, equipment down time data, etc. This would provide the central level with the information required to hold service providers accountable and adjust service contract fees as per the agreement (for example, x % deducted for every additional week of equipment downtime).

5.2.3 Developing a 'business case' for investment in BME personnel and systems

Much data has been collected to date in Zambia on the state and availability of medical equipment, the presence or lack of BME personnel, etc. However very little pricing and comprehensive capital costing information is available that can be compared with the cost of investing in BME personnel and capacity, equipment maintenance and service contracts.

MoH could enable data collection at the central level, from specialized hospitals and at a subset of facilities of other levels on the indicative capital costs of equipment procured for and contained in the facilities. Additional data from inventories on equipment downtimes and the resulting costs of out of service equipment could also be compiled.

This data could be aggregated and compared to the cost of investing in BME personnel and equipping them to do their jobs effectively, essentially producing a 'business case' for investment in BME personnel and capacity building along with new medical equipment procurement.

This business case could be used as powerful support materials to advocate for support for the biomedical engineering profession within Zambia, as it would provide senior decision makers with quantifiable, financial data to justify investments in BME. On top of this, it would be a powerful planning tool, allowing managers to assess maintenance activities in an objective way, i.e. through cost-benefit analysis. It would also add to the growing literature on HTM work in Zambia that has been shared and published internationally.

A partnership with a health economics or health research institute would be a possible avenue for facilitating this research. Interns from the BMET program could collect data at facility level and technical assistance at the MoH could also enable central level data collection and coordination between facilities and those supporting the research.

5.2.4 Partnering to offer more in-service BME training

More opportunities to partner with international professional associations, the private sector, and CPs to support in-service training for existing BME personnel could be harnessed. Effective coordination of this at the central level would be very beneficial.

One such initiative that is already underway is ten reserved spots for Zambian MoH BME personnel in an online training course on equipment maintenance and management offered by the University of Vermont on behalf of the International Federation of Medical and Biological Engineering (IFMBE)'s Clinical Engineering Division (CED).

Many CPs also have the financial capacity to support both in-service maintenance training for medical equipment they supply to support their health programs (such as EmONC equipment for example) and the funding and procurement of tools, test equipment and the spare parts necessary to maintain the equipment.

5.2.5 Advocacy and sensitization with partners to build BME capacity

Advocacy and sensitisation work can be done with the CPs who support the MoH's medical equipment needs to make them more aware of activities they can include in their projects and programs to support BME capacity building that is complementary to their work. For example, adequate user and maintenance training and materials can be included in projects that include equipment supply activities.

More broadly, sensitisation and awareness-raising can be done at the SAG level to promote donor level practices that support HTM capacity building, such as including a minimum 15% budget allocation for maintenance activities in any direct budgetary support for medical equipment procurement, procuring spare parts up front with equipment purchase, etc.

5.2.6 Exploring the set up of an equipment management system

A robust equipment management system captures information centrally from provinces and facilities on equipment inventories, service requirements and contracts, maintenance materials, and other indicators to enable automated reporting and analysis at multiple levels. Equipment

management systems are the main tool for effective HTM and would enable the modernization of HTM within the MoH.

Various systems exist and are used by health systems around the world. Some have been developed for use specifically in health systems in low-resource settings and thus reflect the context in these settings. These systems can store inventories, standard equipment lists, specifications, maintenance requirements and resources, service records and contracts and other relevant information.

Often medical equipment management systems are combined with infrastructure management systems. Typically, they have different modules and can be customized for specific health system's structures, standard equipment lists, specifications, etc. These systems facilitate HTM through the capture and analysis of country-wide medical equipment information.

It must be noted that the implementation and ongoing use of such software systems requires a significant amount of training for the medical equipment personnel involved and a shift in how and what information they capture as part of their regular work, in addition to the investment in the system itself. The behaviour changes required should not be underestimated.

When investigating how such a system may be set up, some learning may be gleaned from the outcomes of the HCISP project and why, for example, the health infrastructure and medical equipment database set up by the project to capture the status of facilities' infrastructure and medical equipment was not being used by the time of the project monitoring visit in Sept-Oct 2016.

One possible medical equipment management system is the [Planning and Management of Assets in Health Services \(PLAMAHS\)](#) software system, which was developed by Health Partners International (HPI) for use in low-resource settings. It is currently being used in Malawi, Nigeria, Nepal and Liberia. HPI can provide a demonstration version of the software to the MoH and THET for review and is able to provide a quotation on request for a customized version of the software based on Zambia's needs.

5.2.7 Developing a country-wide strategy for BME personnel

Several human resources activities relating to the BME cadre in Zambia should be undertaken.

During the dissemination meeting at the MoH on 11 Dec 2016, a suggestion was made by the chair to develop a 2 to 3-year HR strategy for the BME cadre in Zambia as soon as possible. This strategy should include the total number of required BMETs and the total number of available BMETs per year based on projected NORTEC program graduates (i.e. those projected to graduate who are not MoH sponsored and therefore not returning post-graduation to an existing position).

The total number of required BMETs can be estimated by applying the proposed staffing structure that is presented in [APPENDIX H](#) to existing health facilities for public facilities and also for faith-based and private facilities. Private sector positions can also be estimated based on inputs from the main suppliers in country and other knowledge the CMEO has on the private sector. It is hoped this

strategy will also be met with a commitment from the MoH to employ all program graduates from the first two cohorts initially, to ensure the skills of the first BMET graduate cohorts can be fully utilized.

This will be aided by a full country-wide overview of the gaps, which should be prepared by:

- Performing a detailed mapping of frozen and vacant medical equipment posts across the country, based on the establishment and the staff assignments per province
- Performing a mapping of the proposed staffing structure against the current structure, based on the establishment and the staffing assignments per province
- Preparing a summary of the above and presenting it along with the 'business case' to senior MoH leadership and the SAG

Further HR-related recommendations to improve the BME cadre in Zambia include:

- Performing a review of the staffing protocols per level of facility and integrating the proposed medical equipment staffing structure into the protocols if it is not yet included (for example, adding one medical equipment technicians per L1 hospital, etc.)
- Including guidance from HR such as their planning and budgeting tool for facilities to unfreeze and create new positions, in any medical equipment / HTM workshops that happen
- Working continuously to unfreeze positions and to create new posts in line with the proposed structure

6 RECOMMENDATIONS FOR PROVINCIAL LEVEL SERVICE QUALITY IMPROVEMENT

The PMO is the link between facilities and the MoH and likewise, the PME0 links the work of the central medical equipment unit, led by the CME0, to that of the medical equipment personnel within the facilities. Therefore, any work that is done at the facility level and the central level must also include the provincial level.

The PME0 is the main source of technical guidance for medical equipment personnel within facilities. He should be supported and enabled to provide this guidance on any QI initiatives within the facility. It is also strongly recommended some support be provided for a workshop for those working on QI initiatives within facilities.

7 RECOMMENDATIONS FOR FACILITY LEVEL SERVICE QUALITY IMPROVEMENT

Many areas of HTM quality improvement within Copperbelt facilities can be pursued. Projects such as this have the potential to greatly improve key HTM indicators such as equipment uptime. Their effectiveness will be improved through clear problem identification within the facilities themselves, and by working through available technical support such as that provided by the newly revitalised QI committee at PMO level, and with the support of CP's.

7.1 GENERAL AREAS OF RECOMMENDATION

Some recommendations for quality improvement projects within facilities include:

- Setting up a user training program and a user maintenance program, using resources included in [Section 4.7](#) and [APPENDIX J](#)
- Recording all maintenance work requests including cause of failure and problem resolution and performing analysis on the causes and resolutions once per month to guide further areas of focus
- Capturing data on all spare parts required for maintenance work and parts procured for maintenance work to develop a list of most commonly procured spares and developing a proposal to keep these in stock
- Doing an inventory of all user and service manuals available within the facility, identifying gaps and building up a service manual library within the maintenance department (the resources listed in [APPENDIX J](#) provide a good starting point)
- Senior personnel and BME staff working together to guide donors on good medical equipment donation practices to maximize the usefulness of donations (the medical equipment donations toolkit listed in [APPENDIX J](#) provides a good starting point)
- Revitalizing / setting up an equipment management committee within the facility that responds specifically to 1-3 of the most pressing medical equipment challenges within the facility
- Setting up weekly calls and stand up meetings on key equipment maintenance issues with senior management; this tends to be one of the biggest correlations to improved medical equipment status and HTM practices within facilities
- Explicitly listing actual positions/individuals for equipment maintenance and management training sessions sponsored by partners, to ensure the front-line maintenance personnel / those most involved in HTM activities within the facilities themselves are able to avail of the training

It is recommended that each facility involved in QI also be provided with basic tools and test equipment for the BME personnel. The lack of functional tools and test equipment required to put knowledge and skills into practice is a serious impediment to motivation within the workshop.

7.2 QI PROJECT PROCESS

QI projects to improve HTM practices should be planned and executed within the existing MoH framework, using the guidance and tools available. For each QI project, baseline data should be collected at project outset. The QI handbook provides guidance for managing quality improvement projects and the provincial QI committee can provide oversight and technical inputs on the projects.

The national QI guideline is in the process of being updated, and service quality assessments (SQAs) have been prepared for various areas of the health service, including:

- Child, adolescent and maternal health services
- Nutrition
- Operating theatres
- Reproductive cancers
- Paediatric antiretroviral treatment
- Management
- Infection prevention and control
- Health promotion
- Monitoring and evaluation

Each SQA tool includes specific indicators for the following domains:

- Human resources
- Practices
- Guidelines and protocols
- Equipment
- Supplies
- Infrastructure
- Records and data management

Within each domain, several indicators of capacity are captured, with specific instructions for scoring. Once completed, the SQA for a service at a specific facility provides an excellent baseline data set upon which to identify areas most in need of improvement. Baseline data is an essential foundation upon which to build QI initiatives, and an HTM-specific SQA would be a very powerful tool.

Some brief recommendations for specific content for an HTM SQA are presented in Table 7.

Table 7: Recommendations for HTM SQA content

SQA Domain	Recommended high level content areas for capacity indicators
Human resources	<ul style="list-style-type: none"> • Availability of skilled BME personnel in post • Profile of BME personnel in post: qualifications and experience • Number of BME positions in establishment: filled, frozen and unfilled • Services provided by BME team to clinical teams within the facility • Maintenance knowledge, skills and abilities of BME personnel in post
Practices	<ul style="list-style-type: none"> • Maintenance practices, both repair and preventive • Acceptance, installation and commissioning practices • Inventory and inspection practices • Decommissioning and disposal practices • User training and service training practices
Guidelines and protocols	<ul style="list-style-type: none"> • Repair protocols for specific devices • Preventive maintenance protocols for specific devices • Availability of service/user's manuals in the workshop • Implementation of the medical equipment management guidelines • Implementation of medical equipment donation guidelines / best practice
Equipment	<ul style="list-style-type: none"> • Availability and quality of tools/toolboxes for maintenance work • Availability and quality of test equipment, both generic (such as a digital multi-meter) and device specific (such as an oxygen meter)
Supplies	<ul style="list-style-type: none"> • Availability of basic generic spare parts in the workshop • Availability and quality of training materials in the workshop

Infrastructure	<ul style="list-style-type: none"> • Adequate work space for maintenance work, including workbenches • Adequate power supply for workshop • Internet connection for workshop • Adequate office space for computer, record keeping for workshops
Records and data management	<ul style="list-style-type: none"> • Presence and quality of inventory data • Presence and quality of maintenance records for corrective and preventive maintenance • Preventive maintenance schedules • Training records

A domain on placement of the HTM/BME service within the facility would also be very useful to capture. It could include such content areas / indicators as:

- Reporting structure for BME within facility
- Frequency of meetings on equipment issues with senior management
- Ability to control BME budget, procure non-emergency parts, etc.

An HTM-specific SQA would also provide a mechanism for richer, more detailed data collection than is currently possible with the medical equipment indicators in various other tools that must cover all aspects of a facility, such as the performance assessment tool. Any tool that must capture a snapshot of an entire facility's performance will not be capable of capturing detailed information in any specific area.

It is strongly recommended that an HTM-specific SQA be developed and piloted as part of the wider work to improve HTM policies and practices in Zambia.

The TEVETA BMET job description includes the roles/responsibilities a BMET should have within their facility and also includes quality of process and product/service indicators that can be used to measure improvements with BMETs in post. Both provide suggestions for areas of QI work within facilities.

The roles/responsibilities are listed in APPENDIX M, which provides baseline data for BMET involvement at the facilities visited. Any of these roles/responsibilities could form the basis of a QI project within a facility.

The quality of process indicators includes:

- Increase in number of training sessions delivered to equipment users (per month)

- Increase in number of training sessions delivered to other maintenance staff (per month)
- Increase in number of meetings with senior management about equipment (per month)

The quality of product/service include:

- Improvement in turn-around time for equivalent equipment repairs (in hours/days)
- Increase in proportion of preventive maintenance work orders done on schedule (%)
- Increase in proportion of new devices that job holder was consulted on prior to purchase (%)
- Increase in number of up-to-date records in workshop (#)
- Increase in general organization and cleanliness of workshop (qualitative)
- Decrease in health and safety incidents in workshop (#)
- Decrease in user-related repair requests (#)
- Increase in equipment users' confidence in maintenance team (qualitative)

8 CONCLUSIONS

This report has set out the practices and processes related to the management of the lifecycle of medical devices, including their maintenance, in Copperbelt province and at central Ministry level as observed during September, October and November 2016. It has presented findings in the areas of planning and budgeting, procurement, installation and commissioning, use, management and maintenance, decommissioning and disposal. The HTM mapping identified various practices at facility level and between facilities and the PMO and MoH that both help and hinder effective HTM.

There is much that needs to be done to ensure that medical equipment is effectively managed throughout its lifecycle, ensuring maximum possible use, minimum down-time due to maintenance, and therefore effective service delivery which is more cost-efficient for the Zambian health service. This is true both at central level, where improved procurement practices, human resources budgetary allocation, performance assessment tools and maintenance contract negotiation could lead to huge gains nationwide, to facility level where a focus on preventive maintenance, capturing more and better data about equipment, and putting more effort into user training would help make huge gains.

The practices, processes and findings have been presented along with recommendations for QI projects within facilities and recommendations for the improvement of HTM at the central level. There is great potential within the findings and recommendations for the Ministry of Health to extract meaningful and accomplishable interventions to work on immediately. It is reiterated that

there are a number of areas, most notably ensuring positions for graduating technologists, and embarking on detailed inventory keeping, that could result in quick and effective gains. The report should also focus discussions with cooperating partners on how best to improve health service delivery through health technology management.

The author wishes to thank once again all participants in this work for sharing their time, experiences and information freely.

9 APPENDICES

9.1 APPENDIX A – TERMS OF REFERENCE



Physical address: 6833 Mapompo Road, Olympia
 Postal address: Post Box 475, PostnetManda Hill, Lusaka
 Tel | +260974749162
 Email | info@thet.org
 Website | www.thet.org

Terms of Reference

Consultancy: Investigation into Health Technology Management within Zambian Health Facilities

Period of Consultancy: 26th September 2016 – 11th November 2016 (7 weeks).

Location: Lusaka, Zambia and Ndola, Zambia (and surrounding districts).

Background

Tropical Health and Education Trust (THET) is a specialist global health organisation that educates, trains and supports health workers through partnerships, strengthening health systems and enabling people in low and middle income countries to access essential healthcare.

Since 2011, THET has supported the development of the first pre-service training course for medical equipment maintenance professionals in Zambia, a Diploma in Biomedical Engineering Technology at the Northern Technical College (NORTEC) in Ndola. This course was developed as the result of a request by the Ministry of Health (MoH). Previous studies show that around 40% of all medical equipment in Zambia is out of use at any time due to frequent break-downs and difficulties in maintenance.

THET are currently expanding their support to the Biomedical Engineering profession in Zambia, and the medical equipment ecosystem generally. This is because we recognise that the training of maintenance professionals is only part of the answer to the burden of broken equipment and long equipment downtimes; there are also major issues with equipment management, procurement, information gathering and knowledge.

The current consultancy, managed by THET and under the supervision of the Directorate of Clinical Care and Diagnostic Services (CCDS), MoH; is designed to build a more complete picture of the reality of medical equipment management and maintenance at provincial and facility level, and accurately identify the policies, practices and bottlenecks that lead to commonplace medical equipment breakdowns, and the lengthy downtime of medical equipment during repair. The aim is to gather relevant data to assist the Ministry of Health, and Provincial level authorities, and health facilities improve management and maintenance of medical equipment, and the conditions under which equipment maintenance staff operate to bring about their full potential, particularly in light of soon to be graduated Biomedical Engineering technologists entering the workforce.

Purpose

To undertake an investigation into medical equipment management and maintenance practices at provincial and select facility level in Zambia's Copperbelt province, with the aim of identifying problems in health professional's ability to implement effective health technology management, and changes to policy and practice that could enhance the impact of trained Biomedical Engineering Technologists in the workplace.

Key Glossary of Terms

THET (Tropical Health and Education Trust)
 Charity Registration No. 1113101 | Company Registered by Guarantee 5708871 | www.thet.org.uk





Physical address: 6833 Mapompo Road, Olympia
 Postal address: Post Box 475, PostnetManda Hill, Lusaka
 Tel | +260974749162
 Email | info@thet.org
 Website | www.thet.org

THET – the Tropical Health and Education Trust
 HTM – Health Technology Management
 MoH – Ministry of Health (Zambia)
 CCDS – Directorate of Clinical Care and Diagnostic Services, MoH
 NCH – Ndola Central Hospital (Ndola)
 PMO – Provincial Medical Office (Copperbelt), Provincial Medical Officer
 KGS – Kalulushi General Hospital (Kalulushi)
 TDH – Thomson District Hospital (Luanshya)
 STH – St Theresa Hospital (Mpongwe)
 SAHP – St Anthony Health Post (Mpongwe District)

Key Relationships

Edward Tonkin – Programme Manager (HRH) – THET
 Patrick Mumba – Provincial Medical Equipment Officer – PMO
 Gilbert Musonda – Chief Medical Equipment Officer - MOH
 Lupiya Kampengele – Chief Biomedical Engineering Technologist – NCH
 Dr Consity Mwale – Provincial Medical Officer – PMO

Objectives

1. Investigate and report on the current practice of health technology management (HTM) within Zambian health facilities.
 - a. Report should focus on several health facilities of differing levels in Copperbelt Province, including the Copperbelt Provincial Medical Office (PMO). The health facilities concerned to be:
 - i. Ndola Central Hospital (level 3 hospital)
 - ii. Kalulushi General Hospital (level 2 hospital)
 - iii. Thomson District Hospital (level 1 hospital)
 - iv. St Theresa Hospital (urban health centre)
 - v. St Anthony Health Post (rural health post)
 - b. Investigation should include qualitative interviews considering the view of a wide range of key health professionals that are involved in HTM, including:
 - i. Equipment Maintenance and Plant Technicians/Technologists
 - ii. End-users of equipment (Nurses, Clinical Officers, Doctors)
 - iii. Hospital management and administrators
 - iv. Procurement officers
 - v. Finance officers
 - c. Investigation should include an analysis of the current state of medical equipment maintenance in key facilities, with a focus on:
 - i. Amount of equipment in facilities and burden of maintenance
 - ii. Human resources present to fulfil maintenance needs
 - iii. Infrastructure present to fulfil maintenance needs
 - iv. The existence or not of planned preventive maintenance

THET (Tropical Health and Education Trust)
 Charity Registration No. 1113101 | Company Registered by Guarantee 5708871 | www.thet.org.uk



Physical address: 6833 Mapompo Road, Olympia
 Postal address: Post Box 475, PostnetManda Hill, Lusaka
 Tel | +260974749162
 Email | info@thet.org
 Website | www.thet.org

- v. End user knowledge of equipment and maintenance
- vi. Administration knowledge of maintenance
- vii. Equipment management at Provincial, and Facility level including:
 1. Inventory keeping
 2. Planning and budgeting
 3. Procurement processes
- d. As part of the report, produce a detailed process analysis of the life-cycle of medical equipment in Zambian health facilities visited; including:
 - i. Planning, Assessment and Selection
 - ii. Budgeting and Financing
 - iii. Procurement
 - iv. Installation and Commissioning
 - v. User Training
 - vi. Operation and Safety
 - vii. Maintenance and Repair
 - viii. Decommissioning and Disposal
2. Identify and report on key problems raised by individuals relating to the practice of HTM in Zambian health facilities.
 - a. Including but not limited to:
 - i. Any identified issues relating to procurement and supply of equipment, spare parts and consumables which effect the proper use of equipment in clinical settings and the effective maintenance of equipment.
 - ii. The knowledge of and practice of preventive maintenance within facilities.
 - iii. The knowledge levels of maintenance professionals and hospital management of the various aspects of HTM.
 - iv. The state of user training, and end-user knowledge of equipment operation and basic preventive maintenance.
 - v. Information available to planners of equipment inventory, and equipment needs throughout the facility.
 - b. Use certain common items as case studies to investigate the above procedures.
3. Provide overview of strategies or guidelines that could be used to mitigate key identified problems from your knowledge of international best practice, existing resources, and other successful interventions elsewhere in the developing world.
4. Provide update presentation at the completion of the contracted period to key stakeholders.

Governance and Accountability

1. Monthly update reports to be delivered to THET/MOH for purposes of reporting to donors and reviewing objectives (verbal or written).
2. Technical assistance as and when required to donor reporting structures.
3. Provision should be made for a dissemination of initial results via a presentation to key stakeholders

THET (Tropical Health and Education Trust)
 Charity Registration No. 1113101 | Company Registered by Guarantee 5708871 | www.thet.org.uk

9.2 APPENDIX B – INTERVIEW AND FACILITY VISIT SCHEDULE

B.1 Facility visit schedule

Interview date	Facility	Facility/Office	Area
05-Oct	DHO	Masaiti District Health Office	Planning
05-Oct	L2	Roan Antelope General Hospital (RAGH)	Administration
05-Oct	Various	Various - installations and user training	Maintenance
07-Oct	L3	Ndola Central Hospital (NCH)	Finance
10-Oct	L3	Kitwe Central Hospital (KCH)	Administration
11-Oct	L2	Nchanga North General Hospital (NNGH)	Administration
12-Oct	L2	Ronald Ross General Hospital (RRGH)	Maintenance
12-Oct	L2 mining	Malcom Watson Hospital (Mifulira)	Administration
14-Oct	HP	Lumano Health Post (Masaiti)	Users
14-Oct	L1	Masaiti District Hospital	Users
14-Oct	L1	St. Dominic District Hospital	Administration
01-Nov	L3 - Lusaka	University Teaching Hospital (UTH) - Lusaka	Maintenance
11-Nov	L3 - Lusaka	Cancer Diseases Hospital	Maintenance

B.2 PMO visit schedule

Interview date	Level	Office	Area
03-Oct-21Oct	PMO	Copperbelt PMO	Planning
04-Oct-21Oct	PMO	Copperbelt PMO	Medical Equipment
08-Nov	PMO	Copperbelt PMO	Planning
09-Nov	PMO	Copperbelt PMO	Finance
09-Nov	PMO	Copperbelt PMO	Human Resources
09-Nov	PMO	Copperbelt PMO	Human Resources

B.3 MoH visit schedule

Interview date	Office	MoH Directorate	Area
31-Oct-02 Nov	MOH	Clinical Care and Diagnostic Services	Medical Equipment
31-Oct-02 Nov	MOH	Clinical Care and Diagnostic Services	Medical Equipment
31-Oct	MOH	Procurement and Supplies Unit	Procurement

Interview date	Office	MoH Directorate	Area
31-Oct	MOH	Human Resources	Human Resources
31-Oct	MOH	Policy and Planning	Planning
01-Nov	MOH	Human Resources	Human Resources

B.4 PARTNERS VISIT SCHEDULE

Interview date	Organization
25-Oct	UNICEF/MDGi
25-Oct	UNICEF/MDGi
26-Oct	Evelyn Hone College
27-Oct	CHAZ
02-Nov	JICA
02-Nov	Global Fund
04-Nov	DfID
08-Nov	ORBIS

9.3 APPENDIX C – INTERVIEWEES AND CONTACTS

Note: contact information was collected for all interviewees but is not included in this report for confidentiality reasons. This information has been provided to THET and the Copperbelt PMEO and MoH's CMEO.

C.1 Copperbelt Facility Interviewees

Facility/Office	Person	Job title
Masaiti District Health Office	Ms. Ebinet Chata	Planner
Masaiti District Health Office	Ms. Angela Ikowa	Nursing Officer
Roan Antelope General Hospital (RAGH)	Dr. Clara Nauluta	Medical Superintendent
Roan Antelope General Hospital (RAGH)	Mr. Ernest Kateule	Senior Hospital Administrator
Roan Antelope General Hospital (RAGH)	Mr. Geoffrey Mwila	Plumber
Various - installations and user training	Mr. Stephen Mulenga	NORTEC attachment student (UTH)
Various - installations and user training	Mr. Tumeyo Nyenga	NORTEC attachment student (ADCH)
Ndola Central Hospital (NCH)	Mr. Edward K. Musonda	Accountant
Ndola Central Hospital (NCH)	Mr. Lytone Chiwaya	Senior Accountant
Ndola Central Hospital (NCH)	Ms. Denise M. Phiri	Nursing Officer, Obstetrics and Gynaecology Department
Ndola Central Hospital (NCH)	Ms. Betty Mwanza Njunju	Nursing Officer, Medical Department (wards)
Ndola Central Hospital (NCH)	Ms. Loveness Mwale	Nursing Officer, Special Care Baby Unit
Ndola Central Hospital (NCH)	Mr. Peter Kasongo	Principal Hospital Administrator

Facility/Office	Person	Job title
Kitwe Central Hospital (KCH)	Mr. Abdon Champo	Principal Hospital Administrator
Kitwe Central Hospital (KCH)	Dr. Kennedy Gondwe	Acting Head of Clinical Care/Consultant Cardiologist
Kitwe Central Hospital (KCH)	Mr. Daniel Hanyanga	Hospital Engineer
Kitwe Central Hospital (KCH)	Ms. Angela Zulu Chulifya	Clerk (records)
Kitwe Central Hospital (KCH)	Ms. Ephemias Siame	Nursing Officer, Obstetrics and Gynaecology/Acting PNO
Nchanga North General Hospital (NNGH)	Dr. Charles Chichimba	Medical Superintendent / Executive Director
Nchanga North General Hospital (NNGH)	Mr. Gregory M. Llyod	Senior Hospital Administrator
Nchanga North General Hospital (NNGH)	Mr. Watson Mwafulira	Electrician / Head of Maintenance
Nchanga North General Hospital (NNGH)	Mr. Chilala Nyirenda	Senior Accountant
Kitwe Central Hospital (KCH)	Mr. Nyongani Lungu	Medical Equipment Technologist
Kitwe Central Hospital (KCH)	Mr. Festus Mwindilila	Maintenance (Plumber/Handyman)
Ronald Ross General Hospital (RRGH)	Ms. Lucy Longwe	Electrician
Kitwe Central Hospital (KCH)	Mr. George Mangongo	Maintenance (Plumber/Handyman)
Kitwe Central Hospital (KCH)	Dr. John Mwewa	Senior Medical Superintendent
Kitwe Central Hospital (KCH)	Mr. Everisto Mbale	Senior Accountant
Malcom Watson Hospital (Mufulira)	Dr. Gilbert Mukuka	Medical Superintendent

Facility/Office	Person	Job title
Malcom Watson Hospital (Mufulira)	Ms. Charity Tembo	Senior Hospital Administrator
Malcom Watson Hospital (Mufulira)	Mr. Alex Kangwa	Foreman for Medical Instrumentation
Malcom Watson Hospital (Mufulira)	Mr. Kelvin Saka	NORTEC attachment student
Malcom Watson Hospital (Mufulira)	Mr. Teddy Chipunka	NORTEC attachment student
Malcom Watson Hospital (Mufulira)	Mr. Dominic Chitambeya	NORTEC attachment student
Ndola Central Hospital (NCH)	Ms. Muhau Lungwebungu Daka	Senior Planner
Ndola Central Hospital (NCH)	Mr. Lupiyah Kampagnele	Senior Medical Equipment Technologist
Ndola Central Hospital (NCH)	Mr. Constantino Mutale	Medical Equipment Technologist
Ndola Central Hospital (NCH)	Mr. Rogers Banda	NORTEC attachment student
Ndola Central Hospital (NCH)	Mr. Kundananji Simukoko	NORTEC attachment student
Ndola Central Hospital (NCH)	Mr. Gilbert Kalunga	NORTEC attachment student
Ndola Central Hospital (NCH)	Ms. Pascalliner Chilampo	NORTEC attachment student
Ndola Central Hospital (NCH)	Ms. Melai Kabunga	NORTEC attachment student
Lumano Health Post (Masaiti)	Mr. Kalima Mutende	Nurse Midwife
Masaiti District Hospital	Ms. Joan Manda	Nursing Officer
St. Dominic District Hospital	Sr. Elizabeth Njovu	Nursing Officer (in charge)

C.2 Copperbelt PMO Interviewees

Office	Person	Job title
Copperbelt PMO	Ms. Ngosa Kalonge	Planner (Medical Equipment and Infrastructure)
Copperbelt PMO	Mr. Patrick Mumba	Provincial Medical Equipment Officer
Copperbelt PMO	Mr. Mumba Tembo	Senior Planner
Copperbelt PMO	Mr. Layton Gongga	Senior Accountant
Copperbelt PMO	Ms. Grace Shiku	Human Resource Development Officer
Copperbelt PMO	Mr. Peter Mukelabai	Senior Human Resource Management Officer

C.3 MoH and Lusaka Facility Interviewees

MoH Directorate	Person	Job title
Clinical Care and Diagnostic Services	Mr. Gilbert Musonda	Chief Medical Equipment Officer
Clinical Care and Diagnostic Services	Mr. Kennedy Bwalya	Medical equipment technologist
Procurement and Supplies Unit	Mr. Kampamba Mutala	Chief Purchasing and Supplies Officer
Human Resources	Mr. Roy Chihinga	Chief Human Resource Management Officer - Training
Policy and Planning	Mr. Stanley Banda	Strategic Information Liason Officer
Human Resources	Mrs. Mazuba (Tamara) Mukubani	Chief Human Resource Management Officer - Planning

Facility/Office	Person	Job title
University Teaching Hospital (UTH) - Lusaka	Mr. Edward Musakanya	Chief Biomedical Equipment Technologist
University Teaching Hospital (UTH) - Lusaka	Mr. Emmanuel Mwale	Medical Equipment Technologist
Cancer Diseases Hospital	Mr. Ganizani Phiri	Principal Medical Equipment Officer

C.4 CPs and Partners Interviewees

Organization	Person	Job title
UNICEF/MDGi	Dr. Jonas Mwale	MDGi National Manager
UNICEF/MDGi	Ms. Celia Tusiime Kakande	International Programme Manager - MDGi
Evelyn Hone College	Dr. Foster M. Musanje	Head of School - Applied & Health Sciences
CHAZ	Mr. Sandie Simwinga	Program Officer/BME Workshop Lead
JICA	Ms. Mary Mukomba	Programme Officer - Health & Water Sector
Global Fund	Mr. George Mulenga	Senior Procurement Specialist
DfID	Ms. Uzoamaka Gilpin	Health Advisor
ORBIS	Ms. Lucia Mvula-Nadaf	Project Officer: Copperbelt Orbis Africa

9.4 APPENDIX D – RELEVANT MEDICAL EQUIPMENT CONTENT IN THE 2011-2015 HNRP

5.3.3.2 Key Strategies

1. Medical equipment:
 - i) Review, update and implement the Capital Investment Plan (CIP).
 - ii) Strengthen capacity for management and maintenance of medical equipment, including staffing, training and appropriate facilities.

Programmes	Projects to be implemented	ANNUAL TARGETS					Total Output Expected end of SNRP	Responsible Institution(s) and Key Stakeholders
		2011	2012	2013	2014	2015		
Drugs and Logistics Systems	Procurement and distribution of essential drugs and medical supplies	100 %	100 %	100 %	100 %	100 %	Percentage of months for which drugs are in stock at health centres and hospitals maintained at 100% throughout the HNRP period	MoH, CPs, Private Sector, NGOs, CSOs
	Drug Logistics management at all levels	1	-	-	-	-	Establish a functional Pharmaceutical Management Information System incorporating all levels	MoH, CPs, Private Sector, NGOs, CSOs
Infrastructure and Development	Complete on-going construction of hospitals	5	4	6	3	1	19 District Hospitals completed in Chama, Samfya, Shangombo, Lufwanyama, Chiengi, Mpulungu, Nakonde, Serenje, Isoka, Choma, Masaiti, Namwala, Luangwa, Lundazi, Mongu, Milenge, Mwense, Chavuma, and Mkushi.	MoH, MWS
	Establishment of new hospitals	2	3	1	1	-	6 district hospitals established in Kazungula, Chibombo, Gwembe, Mambwe, Lukulu, Ikelenge and Mungwi districts	
	Construction of health posts	80	80	80	80	80	At least 400 new health posts constructed nationwide by 2015	
	Improvement and expansion of existing health centres	50	50	50	50	50	At least 250 existing health centres expanded nationwide by 2015	
	Expansion and upgrading of general hospitals	2	1	1	-	-	4 general hospitals expanded in Kasama, Lewanika and Mansa, and 1 district hospital upgraded in Mazabuka by 2015	
	Modernisation and facelift of University Teaching Hospital and other hospitals	2	3	4	3	3	Hospitals modernised and given a facelift	
	Establish four training schools	2	1	1	-	-	1 training school for clinical officers (Kabwe), two nursing schools (Chitambo and Senanga), and 1 medical and dental school constructed and operational (Ndola)	
	Construction of a National Drug Quality Control Laboratory	-	1	-	-	-	A fully fledged and functional National Drug Quality Control Laboratory established by 2015 in Lusaka	
Develop a functional medical equipment maintenance plan	-	1	-	-	-	A fully fledged and functional medical equipment maintenance plan established by 2015		

Strategies	Interventions	Time frame				
		2011	2012	2013	2014	2015
Capital investment planning	Continue construction of health facilities according to the developed Capital Investment Plan	X	X	X	X	X
	Review of the Capital investment plan to harmonise inputs	X	X			
	Develop strategies to keep the existing infrastructure database updated	X	X			
	Revision of type designs and standard equipment lists of health facilities		X	X		
	Maintenance and rehabilitation guidelines for all levels					
	Finalise policy and develop capacity to support acquisition, management and maintenance of medical equipment.			X	X	

9.5 APPENDIX E – INDICATIVE ANNUAL ACTION PLANNING TIMEFRAME

[Source: Planning handbook for MoH-headquarters and Provincial Health Offices, 2nd edition (May 2011)]

Activity	Timeline
MoH HQ gives PHOs, specialised and 3 rd level hospitals information on financial ceilings, technical planning guidelines and HMIS analysed data for the previous year.	1st wk. May
Provincial Health Office meets with DHMTs and hospitals to review programme guidance and provide other updates (Step 1).	3rd wk. May
DHMT meets with the District Health Advisory Committees to review the previous year's experiences and to obtain their inputs to the next year's plan (Step 2).	4th wk. May
DHMT meets with hospitals providing first level referral services to negotiate bed purchase and agree on the terms of the Memorandum of Understanding (MoUs) (Step 3).	4th wk. May
DHMT briefs first level hospitals, health centre/health post in-charges on programme and any planning updates (Step 4).	4th wk. May
Health centres meet with community representatives to review achievements and problems and to brief on any updates.	1st wk. Jun
Community representatives meet with community to review experiences, determine priorities and to agree on community actions.	2nd wk. Jun
Community representatives meet with health centre staff to draft community action plan.	3rd wk. Jun
2 nd /3 rd level and specialised hospitals meet with their Health Advisory Committees to review progress in the first half year and to receive their input to the next year's plan.	2nd wk. Jun
Hospitals form core planning teams which brief their Departmental Heads.	3rd wk. Jun
DHMT meets with health centres, hospitals, health training institutions and NGOs to draft plans (Step 5).	1st wk. Jul

Health centres meet with community representatives to provide feedback on the projected budget and final community action plan.	3rd wk. Jul
Core hospital planning teams meet Departmental Heads to review next year's departmental allocations and planning launch.	2nd wk. Jul
Hospital departments draft their plans and submit to hospital core planning team.	4th wk. Jul
2 nd /3 rd level hospitals present their plans to the Hospital Advisory Committee; and first level hospitals submit their completed plans to DHMT.	1st wk. Aug
2 nd /3 rd level hospitals present their plans to the Provincial Office; first level hospitals present their plans to their DHMT.	2nd wk. Aug
DHMT drafts the district health office plan (training, supervision, advisory committee expenses, epidemic preparedness, etc.) (Step 6).	2nd wk. Aug
DHMT consolidates district action plan and budget (Step 7).	4th wk. Aug
DHMT presents and defends the district health plan and budget to the Health Advisory Committee and District Development Committee (Step 8).	1st wk. Sept
DHMT submits the District Action Plan to the District Commissioner.	2nd wk. Sept
DHMT submits the District Action Plan to the PHO (Step 9).	2nd wk. Sept
PHO reviews District, Training Institutions, 2nd and 3rd level hospital plans and institutions revise/finalise their plans and resubmit to PHO (Step 10).	3rd wk. Oct
Provinces approve plans, sign MoUs and submit consolidated copies of district, training institutions and 2nd and 3rd level hospital plans to MoH.	3rd wk. Oct
MoH HQ consolidates and submits Health Sector plan and budget to MoFNP.	November

9.6 APPENDIX F – MEDICAL EQUIPMENT CONTENT FROM PLANNING HANDBOOKS – ALL LEVELS

Resource	Relevant sections	Description
Planning handbook for MoH-headquarters and Provincial Health Offices, 2nd edition (May 2011)	Step 2: MOH-HQ/PROVINCIAL ANNUAL PLANNING RESPONSIBILITIES AND SCHEDULE (table)	Annual timeline for action planning activities
	Step 3: MOH HQ/PROVINCIAL HEALTH OFFICE ANNUAL PLANNING RESPONSIBILITIES AND SCHEDULE (flow chart)	Flow chart showing an overview of the process, including activities and units responsible
	Step 4: Results chain template	Includes objectives and key results (outputs) for each overarching priority, includes indicators and means of verification (MoV) for each, along with base data and a target timeframe (1-3 years, i.e. within the MTEF)
	Step 4: Output/activity template	Includes key activities per output, including timeframe (Q1-Q4 in the upcoming year), funding required and funding found (i.e. from GRZ and cooperating partners)
	Step 10: Quarterly Progress report schedule template	Template for reporting on activities by quarter

	Annexes: Worksheets - various	Provide templates and instructions for filling in activity sheets, bottleneck analyses Annex 1: Outline for the Central/Provincial Plan Annex 2: NHSP Theme Codes Annex 3: Bottleneck Analysis Annex 4: Costing Guidelines Annex 5: List of Cost Item Codes for Budget Preparation Annex 6 Technical Updates Template Annex 7: Monitoring and Reporting of Implementation of the Plan Annex 8: Gantt Chart for Summarizing Action Plan by Month
Action planning for hospitals, 5th edition (April 2011)	Section 3.8: Other supportive functions	Section template to describe problems and activities related to equipment maintenance, among other functions
	Box 4.1: Situation analysis contents	Includes 'Buildings, equipment and vehicles' section under 'Resources'
	Table 5.8: Equipment and Furniture Maintenance	Budget template for equipment maintenance requirements, broken down by department
	Table 5.11A: New Medical Equipment and Furniture	Budget template for new capital equipment, broken down by department
	Annex 10: Essential Equipment List for First Level Hospital	Includes a list of basic minimum equipment requirements for a 40-bed level one (district) hospital that offers the following services: OPD/casualty; male and female wards; dispensary; laboratory; radiography; operating theatre; dental unit; physiotherapy; kitchen; laundry and mortuary
Action planning for district health teams, 5th edition (April 2009)	Table 4.7.1: Equipment and Furniture Maintenance	Budget template for equipment maintenance requirements, broken down by DHO, L1 hospital, HC and HP
	Table 4.9.1: New Medical Equipment and Furniture	Budget template for new capital equipment, broken down by DHO, L1 hospital, HC and HP

	Annex 10: Standard Equipment List	-
	Annex 10A: Standard Equipment for Health Post	List of standard equipment per functional area within a HP, including 1-5 prioritization
	Annex 10B: Standard Equipment for Health Centre	List of standard equipment per functional area within a HC, including 1-5 prioritization
	Annex 10C: Standard Equipment for First Level Hospital	List of standard equipment per functional area within a L1 hospital, including 1-5 prioritization
	Annex 11: List of Cost Item Codes for Budget Preparation	Provides cost codes for medical equipment, repair, insurance and maintenance costs
Action planning handbook for health centres, health posts and communities, 5th edition (April 2009)	Section 3.9: Other supportive functions	Section template to describe problems and activities related to equipment maintenance, among other functions
	Annex 10: Standard Equipment List	-
	Annex 10A: Standard Equipment for Health Post	List of standard equipment per functional area within a HP, including 1-5 prioritization
	Annex 10B: Standard Equipment for Health Centre	List of standard equipment per functional area within a HC, including 1-5 prioritization
	Annex 14: List of Cost Item Codes for Budget Preparation	Provides cost codes for medical equipment, repair, insurance and maintenance costs

9.7 APPENDIX G – PREVENTIVE AND CORRECTIVE MAINTENANCE BOTTLENECK ANALYSIS FOR COPPERBELT PMO DRAFT ACTION PLAN

[Source: draft 2017-2019 Copperbelt PMO action plan medical equipment submission]

Coverage determinants	Indicators	Baseline coverage (%)	Bottleneck yes/no	Possible causes of bottleneck	Proposed operational strategies/solutions	Specific activities to be done
Availability of essential commodities	% of health facilities with adequately maintained medical equipment	13%	Yes	Lack of maintenance units inadequate maintenance tools lack of equipment spares and service materials	Construction of maintenance workshops in all health facilities Plan to procure the needed tools and instruments Plan to procure and stock spares and consumables	Plan for the construction of maintenance facilities Procure equipment assessment tools and instruments Procure and stock spares and consumables
Availability of human resources	% of facilities with available trained medical equipment technicians	13%	Yes	Lack/inadequate positions for medical equipment technicians in institutions	Lobby for the creation of these staff positions in facilities that do not have	Make submission to MoH HQ through HR

				Lack of trained technicians	Identify staff to send for training in medical equipment engineering	Submit list of recommended staff to go for training
Physical accessibility	% of health facilities with accessibility to services of medical equipment technicians	13%	Yes	Most hospitals and DHOs do not have positions for medical equipment technicians	Facilities to be provided with the services of equipment technicians	Make timely submission of requests for equipment technicians through PHO
Initial utilization	% of health facilities able to access preventive and corrective maintenance services for medical equipment	100%	No			
Timely continuous utilization	% of health facilities adhering to a maintenance schedule for equipment	13%	Yes	Facilities do not have equipment corrective and preventive maintenance plans and schedules	Develop schedules for all maintenance works	Hospitals and Districts to form Medical Equipment Management Committees Institutions to conduct medical

						equipment assessments Submit quarterly updated inventory to PHO
Effective quality	Provision of adequate preventive and corrective maintenance works for medical equipment in facilities	13%	Yes	Inadequate equipment tools, service manuals and spares Inadequate specialized skills of modern equipment	Plan for the procurement of needed tools, spares and service manuals Institutions to plan for their staff training	Purchase needed equipment assessment tools, spares and service manuals Technicians to undergo regular updates on new advanced equipment available in hospitals

9.8 APPENDIX H – PROPOSED MEDICAL EQUIPMENT STAFFING STRUCTURE

[Source: Medical Equipment Unit, Directorate of Clinical Care and Diagnostic Services, Nov 2016]

DEPARTMENT STAFFING PROPOSAL MoH H/Qs

EXISTING STRUCTURE			PROPOSED STRUCTURE			
Position	Salary Scale	Number	Position	Salary Scale	Number	Justifications
Chief Medical Equipment Officer	MS 1	01	Chief Medical Equip Officer	MS 01	01	Share responsibility and improve on efficiency
Nil	Nil	Nil	Principal Medical Equip Off	MS 02	01	

Tertiary Level Hospital U.T.H

Existing Structure			Proposed Structure			
Position	Salary Scale	Number	Position	Salary Scale	Number	Justification
Chief Medical Equip Technologist	MS 04	01	Principal Medical Equip Off	MS 03	01	Handles High Tech and specialized Equipment
Principal Medical Equip Technologist	MS 05	01	Chief Medical Equip Technologist	MS 04	01	Have more responsibility for such a Health facility
Senior Medical Equip Technologist	MS 06	01	Principal Medical Equip Technologist	MS 05	01	
Medical Equipment Technologist	MS 07	05	Senior Medical Equip Technologist	MS 06	03	

Senior Medical Equip Technician	MS 08	01	Medical Equipment Technologist	MS 07	08	
---------------------------------	-------	----	--------------------------------	-------	----	--

Tertiary Level Hospital- Cancer Diseases Hospital

Existing Structure			Proposed Structure			
Position	Salary Scale	Number	Position	Salary Scale	Number	Justification
Medical Equipment Technologist	MS 07	01	Principal Medical Equip Officer	MS 03	01	Handles High Tech and specialized Equipment for the all nation
Medical Equipment Technologist	MS 07	01	Chief Medical Equipment Technologist	MS 04	01	Structure at CDH from initial was not well done it had a lot of gaps and the facility is still expanding
Nil	Nil	Nil	Principal Medical Equip Technologist	MS 05	02	
Nil	Nil	Nil	Senior Medical Equip Technologist	MS 06	02	
Nil	Nil	Nil	Medical Equip Technologist	MS 07	04	

3rd Level Hospital

Existing Structure			Proposed structure			
Position	Salary Scale	Number	Position	Salary Scale	Number	Justification
Medical Equipment Technologist	MS 07	01	Principal Medical Equip Technologist	MS 05	01	Facilities like NCH,KCH,ADH are being upgraded and with the coming up of the School at NORTEC for Medical Engineering
Medical Equipment Technologist	HB 04	02	Senior Medical Equip Technologist	MS 06	01	
Nil	Nil	Nil	Medical Equipment Technologist	MS07	02	
Nil	Nil	Nil	Senior Medical Equip Technician	MS 08	02	

2nd Level Hospitals

Existing Structure			Proposed Structure			
Position	Salary Scale	Number	Position	Salary Scale	Number	Justification
Medical Equipment Technician	HB 13	01	Senior Med Equip Technologist	MS 06	01	Upgrading of facilities have more equip and more responsibilities and with the opening of Medical

						Engineering School at NORTEC MoH need to expand to accommodate the graduates
Nil	Nil	Nil	Medical Equip Technologist	MS 07	02	
Nil	Nil	Nil	Senior Medical Equip Technician	MS 08	01	

9.9 APPENDIX I – MoH STANDARD MEDICAL EQUIPMENT MAKES AND MODELS PROPOSAL

[Source: Medical Equipment Unit, Directorate of Clinical Care and Diagnostic Services, Nov 2016]

The Ministry of Health, Zambia wishes to advise all stakeholders and procurement entities with the provision of Medical Equipment that below are the Standardized for use in all Public Health facilities for various platforms.

This means that every partner wishing to procure equipment or accessories for the Ministry of Health should be guided by the list below.

Item No	Name of Equipment	Recommended Make
1.	Autoclave/Sterilizer	Sakura-Japan Prioclave-UK Hosp Sterilier-RSA Tuttaner-UK
2.	Infant Incubator	Dragger-German Atom-Japan Air shield-UK GE-USA/UK
3.	Infant Resuscitation Unit	Dragger-German Atom-Japan Air shield-UK GE-USA/UK
4.	Imaging-X ray/Ultrasound	Siemens-German

		Toshiba-Japan GE-USA/UK Philips-Netherland Neusoft-China Allenger-India
5.	Automatic Film Processor	Agfar-Europe Kodak-Japan Diasang-Korea
6.	Mortuary Units	Blue Star-India Foster-Europe Club Refrigeration-UK
7.	Gen Sets	Cummings-UK Perking-UK Dorman-UK Caterpillar-USA Stamford-UK
8.	Operating Table	Eschmann-UK Mizuho-Japan
9.	Operating Light	Maquet-France

		Med-lamp-UK Philips-EU DrMoich-Europe
10.	Suction Machine/Vacuum Extractor	Gabler-RSA Eschmann-UK
11.	Medical Oxygen Concentrator	Devilbiss-USA Air shield-UK/USA BBraun-UK
12.	Electro Surgical Unit	Eschmann-UK Erbe-German Braun-UK Vellelab-USA
13.	Anesthesia Machine	Dragger-German GE-UK Acoma-Japan Ohmeda-Japan
14.	Critical Care Patient Ventilator	Newport-USA Purittan Bennet-USA Philips-Europe

		Siemens-German Accoma-Japan
15.	Infusion /Injector Pump	Atom-Japan BBraun-German Accoma-Japan Braun-UK Schiller-France
16.	Renal Unit	Fresenius-German Gambro-Sweden
17	Dental Equipment	Fona-Denmark Anthos-Italy Gnee-Brizil
18	Ophthalmology Equipment	Olympus-Japan Topcon-Japan Haagstrat-German Eyeco-UK Carl Zesis-German Index-USA Scoptics-Australia

19	Laundry Machines	Electrolux-Sweeden/UK Miele-German Imesa-Italy Norva-Denmark SpeedQueen-USA
20	Kitchen Equipment	Vulcan-RSA
21	Physiotherapy Equipment	ENRAF Nonius-Neatherlands

9.10 APPENDIX J – USEFUL TRAINING MATERIALS

I.1 Online libraries of information

[Frank's Hospital Workshop](#) is a collection of documents, experiences, best- practice procedures and teaching and learning materials about biomedical technology. It includes electronic and biomedical training modules, a library of service and user manuals, and datasheets for medical devices.

[Engineering World Health's Digital BMET Library](#) includes troubleshooting guides for equipment, generic PM procedures, textbooks on medical instrumentation and equipment, health technology management and BME curriculum areas such as anatomy and physiology, electronics, etc.

I.2 Books available online

Care and Safe Use of Hospital Equipment - VSO Books (1995) - Skeet M and Fear M: provides practical advice for hospital staff about proper management of equipment, including guidelines on preventive maintenance and service, simple user instructions, checklists for correct and safe use of equipment and basic technical information for training of first-line maintenance staff.

Medical supplies and equipment for primary health care: A practical resource for procurement and management - ECHO (2001): for health workers responsible for selecting and managing medical equipment for primary health care services in low- resource settings.

Diagnostic Imaging in the Community: a Manual for Clinics and Small Hospitals - PAHO and Rotary International (2011): for clinics and small hospitals that are deciding whether or not to offer diagnostic imaging services, or already have the equipment and need to set it up and run it safely.

MAINTENANCE Manual for Laboratory Equipment (2nd edition) WHO and PAHO (2008): covers the purpose, operation, installation, use, troubleshooting, preventive maintenance and good practice for laboratory devices including: microplate readers, microplate washers, pH meters, balances, water baths, biological safety cabinets, centrifuges, water distillers, dilutors, spectrophotometers, autoclaves, drying ovens, incubators, microscopes, pipettes, heating plates, refrigerators and freezers, chemistry analysers and colorimeters.

Guide to Ophthalmic Equipment ORBIS (2004): introduces some of the more commonly used devices and is mainly written for persons who are not eye care professionals wishing to know what each device looks like and to understand how it is used.

'How to Manage' series of health care technology guides Ziken International (2005): series of guides detailing how to manage health care technologies in low-resource settings covering the following topics very comprehensively:

- Guide 1 – how to organize a system of healthcare technology management
- Guide 2 – how to plan and budget for healthcare technology
- Guide 3 – how to procure and commission your healthcare technology
- Guide 4 – how to operate your healthcare technology effectively and safely
- Guide 5 – how to organize the maintenance of your healthcare technology
- Guide 6 – how to manage the finances of your healthcare technology management team

9.11 APPENDIX K – PUBLICLY AVAILABLE MEDICAL EQUIPMENT SPECIFICATIONS

Several sources of technical specifications for medical equipment exist in the public domain:

- WHO Technical Specifications for 61 medical devices most commonly required in low-resource settings – available [here](#)
- WHO Technical Specifications for 13 UN Commission on Life Saving Commodities devices – available [here](#)
- WHO Technical Specifications for oxygen concentrators – available for download [here](#)
- WHO Technical Specifications for newborn resuscitation devices – available for download [here](#)
- UNICEF Supply Catalogue, specifically the specifically the medical equipment, renewable and medical kit sections – available [here](#)
- UNFPA Product Catalogue – available [here](#)
- Government of India, National Health Mission Technical Specifications of Medical Devices for Laboratory and Radiology – available [here](#)
- Government of Nepal, Ministry of Health and Population Technical Specifications for Medical Devices - available [here](#)

In addition to these sources, many of the resources included in Appendix J include some technical specifications.

9.12 APPENDIX L – SUMMARY OF BME PERSONNEL’S INVOLVEMENT IN HTM WITHIN THEIR FACILITIES

Qualitative data on the level/frequency of engagement BME personnel have with HTM activities in their facilities was collected during facility visits using the TEVETA job profile’s list of roles and responsibilities and tasks as a framework. This data provides a rough indication on how involved the BME teams are within their facilities in HTM activities. The data itself is observational; extracted from interviews with the BME personnel. Note that CNBD means the data could not be determined.

The HTM frequency of engagement summary is:

#	Role/Responsibility	L3	L3	L2	L2	L2	L2 mining	Other
		Ndola Central	Kitwe Central	Nchanga North	Roan Antelope	Ronald Ross	Malcolm Watson	CHAZ workshop
1	Carryout pre-purchase activities	SOMETIMES	RARELY	SOMETIMES	CNBD	NEVER	OFTEN	N/A
2	Purchase of medical equipment	SOMETIMES (ALWAYS for spare parts)	RARELY (ALWAYS for spare parts)	RARELY	CNBD	NEVER	OFTEN	N/A
3	Installation and commissioning of medical equipment	OFTEN	RARELY	SOMETIMES	CNBD	SOMETIMES	OFTEN	SOMETIMES
4	Preventive maintenance of medical equipment	RARELY	SOMETIMES	RARELY	CNBD	NEVER	OFTEN	RARELY
5	Repair of medical equipment	OFTEN	OFTEN	OFTEN	OFTEN	OFTEN	ALWAYS	OFTEN

6	Calibration and safety testing of medical equipment	RARELY	NEVER	CNBD	CNBD	NEVER	OFTEN	SOMETIMES
7	Training for medical equipment users, other support staff and industrial attachment students	SOMETIMES	SOMETIMES	SOMETIMES	CNBD	NEVER	OFTEN	OFTEN
8	Inventory of medical equipment	OFTEN (MOST RECENT = 2015)	OFTEN (MOST RECENT = 2015)	OFTEN (MOST RECENT = 2015)	NEVER	NEVER	ALWAYS (DONE BY CENTRAL PLANT)	N/A
9	Decommissioning of medical equipment	SOMETIMES	RARELY	OFTEN	CNBD	NEVER	ALWAYS	SOMETIMES
10	Managing workshop resources	OFTEN	OFTEN	OFTEN	CNBD	CNBD	OFTEN	OFTEN
11	Adhering to good practice standards	CNBD	CNBD	CNBD	CNBD	CNBD	ALWAYS (FACILITY IS ISO 9001 CERTIFIED)	CNBD
12	Adhering to all relevant health, safety and environmental practices and standards	CNBD	CNBD	CNBD	CNBD	CNBD	CNBD	CNBD

13	Budgeting for equipment maintenance	SOMETIMES	RARELY	RARELY	CNBD	NEVER	OFTEN	SOMETIMES
14	Conduct secretarial duties for the medical equipment management committee	NEVER - NO COMMITTEE						
15	Project management	CNBD						

Specific tasks included in each role/responsibility area include:

Role/Responsibility

1 Carryout pre-purchase activities

- Writing technical specifications for new medical equipment
- Identifying clinical need for equipment
- Understanding users' requirements for equipment
- Defining technical specifications
- Defining service requirements (manuals, training, etc.)
- Preparing the specifications document with relevant parties (users, purchasing officer, etc.)
- Reviewing infrastructure adequacy for installation readiness

2 Purchase of medical equipment

- Evaluating bids, according to PPA guidelines
- Clarifying bid details as required
- Selecting most appropriate bid

- Awarding most appropriate bid
- Pre-installation site preparation logistics planning
- Communicating plans to all relevant parties

3 Installation and commissioning of medical equipment

- Comparing goods received to equipment purchase order (and ensuring there is a physical place designated for this task)
- Evaluating any infrastructure changes made to site location
- Reviewing any equipment performance records (reliability, etc.)
- Assembling all relevant equipment components (and ensuring there is a physical place designated for this task)
- Visually inspecting the equipment and location site
- Collect, log and safely store user and maintenance manuals (follow up if manuals are missing)
- Performing electrical safety tests
- Performing mechanical safety tests
- Coordinating with any relevant inspection agencies for equipment-specific safety tests
- Performing all functional tests outlined in the manual(s)
- Arranging user training for equipment (on operation and user maintenance)
- Arranging service training for other maintenance personnel
- Recording the installation and commissioning work and filing records of any training, compliance certifications and as-built drawings

4 Preventive maintenance of medical equipment

- Planning for preventive maintenance work, including risk assessing the schedule and making changes based on local practice as necessary
- Changing all parts recommended in the procedure
- Carrying out all function tests recommended in the procedure
- Calibrating all components recommended in the procedure
- Ensuring the work area is cleaned after the work

- Reviewing any functional changes with the equipment users
- Recording the preventive maintenance work

5 Repair of medical equipment

- Documenting the receipt of an equipment repair request
- Ensuring all anti-static, infection and decontamination protocols are appropriately followed
- Troubleshooting the fault with correct tools, manuals and drawings as required
- Consulting relevant staff and technical literature as required
- Consulting users who reported the fault for information as required
- Sourcing parts if necessary
- Rectifying the fault
- "Reviewing any functional changes and the cause of the fault with the equipment users (to correct behaviour if necessary)
- Recording the corrective maintenance work

6 Calibration and safety testing of medical equipment

- Calibrating all components of equipment with appropriate calibration kits and test equipment
- Safety testing of medical equipment
- Ensuring test and calibration equipment are calibrated as per the manufacturer's specification (in-house or by third party)
- Recording the calibration and safety testing work

7 Training for medical equipment users, other support staff and industrial attachment students

- Training users on operation and care of medical equipment
- Training other medical equipment staff on maintenance of medical equipment
- Supervising students on industrial attachment
- Assessing trainees' foundational, practical and reflexive competencies
- Recording trainees' competencies
- Monitoring trainees' competencies and providing refresher training as necessary

8 Inventory of medical equipment

- Performing periodic inventory of medical equipment
- Identifying service and training gaps based on inventory
- Documenting actions arising from inventory
- Rectifying the hospital's asset register based on the inventory
- Presenting inventory findings to senior management for planning purposes

9 Decommissioning of medical equipment

- Evaluating need for decommissioning
- Removing equipment from service
- Submitting recommendation to decommission to Board of Survey
- Rendering equipment unusable and destroying patient data
- Stripping equipment for spare parts
- Updating inventory and asset register
- Disposing of equipment as per organisation's procedure and relevant national and international guidelines

10 Managing workshop resources

- Managing staff members
- Managing the budget for workshop resources and activities
- Managing tools
- Managing test equipment
- Managing spare parts
- Managing service and user manuals
- Managing other training materials
- Managing work bench space
- Managing equipment record systems

- Archiving equipment record systems with the hospital's information system
- Ensuring an orderly and safe workspace

11 Adhering to good practice standards

- Complying with organisational best practice standards (including emergency preparedness and disaster response procedures)
- Complying with relevant Ministry of Health and national best practice standards
- Adhering to relevant international best practice standards for managing and maintaining medical equipment
- Applying principles from a quality management system (ex: ISO, KAIZEN) to work

12 Adhering to all relevant health, safety and environmental practices and standards

- "Applying IEC 60601 (BSEN 60601) and collateral and particular equipment standards to patient and operator safety considerations "
- "Interpreting international equipment manufacturers' markings (ex: CE, JIS, etc.) for patient and operator safety considerations "
- Complying with organisational health, safety and environmental management practices
- "Correctly using any health and safety equipment (x-ray dosimeter, personal protective equipment) necessary for the work "
- Performing safety testing on medical equipment

13 Budgeting for equipment maintenance

- Using paper and computer based budgets
- Budgeting for workshop materials (spare parts, etc.)
- Budgeting for preventive maintenance consumables
- Budgeting for workshop resources
- Budgeting for training
- Budgeting for tools and test equipment

14 Conduct secretarial duties for the medical equipment management committee

Preparing agenda for medical equipment committee

- Taking minutes
- Arranging meetings
- Prepare technical reports for medical equipment committee
- Technical follow ups and action items

15 Project management

- Applying project management principles to work
- Planning the project
- Implementing the project
- Managing risks
- Quality management
- Closing the project

9.13 APPENDIX M – MEDICAL EQUIPMENT WORKSHOP RESOURCES

The resource data was collected during facility visits. It provides a rough indication of the resources available in each workshop, although minor inaccuracies may be present due to the brevity of some visits and the fact that information was gathered from non-BME personnel in some facilities where the BME leads were not present during the visit. Note that CNBD means the data could not be determined.

M1: Workshop environment

Resource	Qty	L3	L3	L2	L2	L2	Other - L2 mining	Other
		Ndola Central	Kitwe Central	Nchanga North	Ronald Ross	Roan Antelope	Malcolm Watson	CHAZ workshop
Sufficient working space with working table and chair	-	partial, more space required	yes	partial, no workbench	partial	yes, shared workspace	yes	yes
Air, ventilation and lighting	-	yes	yes	partial	partial	yes, partially outside	yes	yes
Power supply	-	partial, not variable supply	yes	yes, three phase power	partial, not variable	CNBD	yes	partial, not variable supply
Sink with running water	-	partial, inconsistent supply	yes	partial, available outside	partial, inconsistent supply	CNBD	yes	yes
Office desk with chair	-	yes	yes	yes	yes	yes	yes	yes

Locker or shelf for measuring instruments and manuals	-	yes	yes	yes	no	CNBD	yes	yes
Fire extinguisher	-	no, one available in electrical workshop	yes	yes	no	CNBD	yes	yes
Air compressor	-	no, one available in electrical workshop	no	partial, one available in laundry	no	CNBD	partial, one available at main plant	no

M2: Tools

Resource	Qty	L3	L3	L2	L2	L2	Other - L2 mining	Other
		Ndola Central	Kitwe Central	Nchanga North	Ronald Ross	Roan Antelope	Malcolm Watson	CHAZ workshop
Vice Grip	1	no	no	partial, needs repair	no	yes	yes	yes
Hacksaw (Big)	1	no	no	yes	no	yes	yes	yes
Hacksaw (Mini)	1	no	no	yes	no	yes	yes	yes
Digital Multimeter	1	yes	yes	yes	yes	CNBD	yes	yes

Temperature Probe	1	yes	yes	no	yes	CNBD	yes	no
Adjustable Wrench (Big)	1	partial, available but personal tools	no	yes	yes	CNBD	yes	yes
Adjustable Wrench (Mini)	1	partial, available but personal tools	no	yes	no	CNBD	yes	yes
Short Nose Pliers	1	yes	yes	no	no	CNBD	yes	yes
Long Nose Pliers	1	partial, available but personal tools	no	yes	yes	CNBD	yes	yes
Pen Knife	1	partial, available but personal tools	no	no	partial, needs repair	CNBD	yes	yes
Diagonal Cutter (Big)	1	no	no	no	no	CNBD	yes	yes

Diagonal Cutter (Small)	1	no	no	no	no	CNBD	yes	yes
Set of Allen KEY	1	partial, available but personal tools	yes	no	yes	CNBD	yes	yes
Multi Function KEY	1	no	no	no	yes	CNBD	yes	yes
Wire Stripper	1	partial, available but personal tools	no	no	no	CNBD	yes	yes
Set of Screw Driver (Include precision type)	6	partial, no precision type	partial, no precision	partial, no precision	partial, no precision	CNBD	yes	yes
Voltage Tester Screw Driver	1	no	no	no	no	CNBD	no	no
Adjustable Wire Stripper	1	no	no	no	no	CNBD	yes	no
Pen Light	1	yes	no	no	yes	CNBD	yes	no
Plumber's Pliers	1	no	no	no	no	CNBD	no, maybe in plant	yes
Measuring Tape	1	no	no	yes	no	CNBD	yes	yes

Solder sucker	1	yes	no	no, but have solder	no	CNBD	yes and to soldering set	yes
Brush (for dust removal)	1	yes	no	no	no	CNBD	yes	yes
Blower	1	no	no	yes	no	CNBD	yes	yes

M3: Test equipment

Resource	Qty	L3	L3	L2	L2	L2	Other - L2 mining	Other
		Ndola Central	Kitwe Central	Nchanga North	Ronald Ross	Roan Antelope	Malcolm Watson	CHAZ workshop
Electrical safety analyzer	1	yes	no	no	no	CNBD	partial, one in electrical	no
ECG simulator	1	no	no	no	no	no	no	no
Oxygen analyzer	1	yes	no	no	no	no	no	partial, needs new filter
Defibrillator analyzer	1	no	no	no	no	no	no	no
Electro surgical unit analyzer	1	no	no	no	no	no	no	no
Infusion pump analyzer	1	no	no	no	no	no	no	no
Pulse oximeter simulator	1	yes	no	no	no	no	no	no

Ventilator analyzer	1	partial, shared with ADH	no	no	no	no	no	no
Phantom for ultrasound diagnosis	1	no	no	no	no	no	no	no
Phantom for X-ray test	1	no	no	no	no	no	no	no
QC kits for X-ray	1	no	no	no	no	no	no	no
Anaesthesia gas analyzer	1	no	no	no	no	no	no	no

M4: Other

Resource	Qty	L3	L3	L2	L2	L2	Other - L2 mining	Other
		Ndola Central	Kitwe Central	Nchanga North	Ronald Ross	Roan Antelope	Malcolm Watson	CHAZ workshop
Internet		no	yes, in office	no	no	no	no	yes
Service manuals		some	some	very few	CNBD	CNBD	yes	partial, some
Training materials		some available	some available	some available	CNBD	CNBD	few available	yes

9.14 APPENDIX N – LIST OF SUPPORTING DOCUMENTATION SUPPLIED

N1: Mapping resources

- Action plans for hospitals included in the mapping (2016-2018)
- Most recent inventories for facilities included in the mapping
- Most recent provincial inventory for Copperbelt province
- Summary of HTM policies and practices summary for facilities included in the mapping
- Sample work request forms from facilities included in the mapping
- Sample PM schedules from facilities included in the mapping
- Sample spare parts procurement paperwork from facilities included in the mapping
- Sample board of survey decommissioning
- Copperbelt workshop ‘medical equipment life cycle mapping’ slides (Ndola, 10 Nov 2016)
- MoH mapping dissemination results meeting slides (Lusaka, 11 Nov 2016)

N2: Ministry of Health resources

- National Human Resources for Health Strategic Plans (2006-2010 and 2011-2015)
- Actions plans for MoH DCCDS units (2016-2018)
- Performance assessment tool (current – Nov 2016)
- Quality improvement guideline (draft – Nov 2016)
- Planning handbooks for centre, district, hospital, health centre and statutory boards (2011)
- Provincial action plan for Copperbelt province (2016-2018)
- Copperbelt DMO, L3 and L2 facility action plans (2016-2018)
- Job description for medical equipment technologist (current, Nov 2016)

N3: Ministry of Health HCISP resources (IICA)

- National guidelines for health facility management in Zambia (2012)

- Medical equipment management guidelines (2012)
- Medical equipment standard lists for second level hospitals (2012)
- Medical equipment standard lists for third level hospitals (2012)
- Technical training textbook (2011)
- Standard inventory template (2012)

N4: Ministry of Health EmONC equipment resources (DFID)

- EmONC equipment maintenance reports (Crown Agents, 2011)
- Independent audit report (Shauna Mullally for Oxford Policy Management, 2013)

N5: TEVETA resources

Job description for biomedical engineering technologist (current, draft 2012)

N6: THET resources

Making it work: a toolkit for medical equipment donations (Shauna Mullally for THET, 2013)