THE UNITED REPUBLIC OF TANZANIA

THE NATIONAL MEDICAL OXYGEN SCALE-UP PLAN

THE MINISTRY OF HEALTH



EMERGENCY PREPAREDNESS AND RESPONSE UNIT

JUNE 2022

EXECUTIVE SUMMARY

Medical Oxygen is an essential medicine, it is therefore very important to assess availability of different sources of oxygen, as well as the delivery and supply systems to the patient, in order to prioritize, reallocate and compare with calculated numbers to define the needs. As of April 4, 2020, global supply-chain issues remained extremely disrupted as a result of the COVID-19 pandemic. It was strongly recommended that Ministries of Health leverage existing supplies and resources, where possible, in order to enable an immediate response.

The United Republic of Tanzania conducted the initial assessment in May, 2020 the time at which the country was responding to the first wave of COVID-19. The assessment aimed at quantifying the country's capacity to produce and supply oxygen to the healthcare facilities. It was determined that, of the required oxygen needs only 20% of oxygen was being produced in the country. The projected oxygen needs in the country was estimated to be 29,000 Litres per minute. Over time, taking into consideration, the heavy investments being done by the ministry of health and president's office, Regional Administration and local government (PO – RALG) the gap has widely been increasing.

The Ministry intends to increase the oxygen production and supply to healthcare facilities by increasing the production to bridge the 80% gap of oxygen needs and ensure effective supply and use of medical oxygen in the healthcare facilities in the country by investing in the key areas as highlighted below;

MEDICAL OXYGEN SCALE UP		
SN	**INVESTMENT AREA**	**COST (TZS)**
1	Medical oxygen sources and production	429,365,673,000
2	Inter - & intra facility medical oxygen transportation	267,747,960,000
3	Coordination of Oxygen Scale-up activities implementation	4,117,165,000
4	Medical Equipment Management (MEM) and Medical Oxygen Supply Sustainability	20,850,260,000
5	Healthcare workers capacity building (Training, mentoring and supervision)	129,210,075,000
6	Monitoring & Evaluation	9,524,941,000
7	Improve medical Oxygen usage	125,800,055,000
GRAND TOTAL		**986,616,129,000**

FOREWORD

A dramatic increase in demand for oxygen therapy, especially during peak seasons of COVID-19, has uncovered a global shortage of medical oxygen supply systems. In Tanzania, the key identified causes of such scarcity were a lack of oxygen production capacity, ineffective operation of existing oxygen plants, shortage of oxygen cylinders, shortage of commercial suppliers to refill and distribute oxygen cylinders, and frequent breakdown of mobile oxygen concentrators. This discovery prompted the need for the country to develop a comprehensive strategic plan for improving the availability and reliability of oxygen and the coverage of quality oxygen therapy at all levels of healthcare facilities for health system's resilience.

The National Medical Oxygen Scale Up Plan, is an investment strategic document intended to be implemented in the next five years (2022-2027). The task projected to be done jointly between the government, development partners, private sector and other key stakeholders in the healthcare sector. A comprehensive scale-up plan for medical oxygen systems is to be effectively implemented to ensure availability, accessibility, and affordability of quality medical oxygen therapy to meet universal health coverage in the country.

The ministry of health is committed towards ensuring health related infrastructures are considerate of the medical oxygen production, transportation and delivery systems, whereas for a desired impact of the named product to be sustained; a functional coordination mechanism at all levels, availability of guidelines and SOPs and well trained human resource for health are of paramount importance, the pillars to which the ministry is committed to and implements throughout its jurisdictions to date.

Prof. Abel N. Makubi
PERMANENT SECRETARY

ACKNOWLEDGEMENT

This plan was developed following a joint efforts of various stakeholders who supported the country during COVID-19 pandemic response. The gratitude is to be expressed to the Oxygen Technical Working Group, a subcomponent of the case management and infection prevention and control pillar for initiating the forum for discussions of issues around oxygen from the beginning of the pandemic. Also, for coordinating the initial assessments which provided baseline information on the status of oxygen production and use in the country.

Special thanks are expressed to all partners who technically and financially supported the ministry towards development of this plan; to name a few, The world Health Organization (WHO), UNICEF, World Bank, Global Fund, Clinton Health Access Initiative (CHAI), PATH, FHI360 and other key implementing partners.

The ministry also recognizes the contributions provided by other ministries that includes, the President's Office Regional Administration and Local Government (PO RALG), Ministry of Finance and Planning and Prime Minister's Office (Disaster Management Department).

I appreciate the committed efforts contributed by the emergency preparedness and Response Unit (EPRU), Directorate of Curative Services (DCS), healthcare Technical Services Section (HCTS) and Directorate of Policy and Planning (DPP) for coordinating the development of this plan to its completion. It's my call to all stakeholders, as we join this venture of improving the health system towards its resilience, be part and parcel of implementing this plan.

Prof. Tumaini J. Nagu

CHIEF MEDICAL OFFICER

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1.0 Background Information

A dramatic increase in demand for oxygen therapy, especially during peak seasons of COVID-19, has uncovered a global shortage of medical oxygen supply systems. In Tanzania, the key identified causes of such scarcity were a lack of oxygen production capacity, ineffective operation of existing oxygen plants, lack of oxygen cylinders, shortage of commercial suppliers to refill and distribute oxygen cylinders, and frequent breakdown of mobile oxygen concentrators. This discovery prompted the need for the country to develop a comprehensive strategic plan for improving the availability and reliability of oxygen and the coverage of quality oxygen therapy at all levels of healthcare facilities.

In April 2020, the Case Management and IPC Sub-Committee at the Tanzania Ministry of Health, Community Development, Gender, Elderly and Children (MoH) established the Oxygen Group. The Oxygen Group is comprised of representatives from the Ministry, WHO Tanzania and other development agencies and partners. The group's objectives were to conduct a rapid assessment of the situation of oxygen in Tanzania, understand the needs and priorities for scale-up, and develop a plan and investment strategy for the scale-up of oxygen production, supply and use in the country.

The scope of the assessment included hospitals in Tanzania with on-site oxygen PSA plants and commercial/private companies generating and supplying oxygen to hospitals.
The assessment aimed to:

i. Evaluate each hospital's oxygen plant and its ability to satisfy the needs of the hospital and subsequently assess the possibility of supporting nearby healthcare facilities in need of oxygen supply
ii. Determine the capacity of commercial/private oxygen suppliers in terms of extent, availability and reliability to generate and supply oxygen to healthcare facilities within the geographical area and assess the possibility of extending the services to other regions in need of oxygen supply
iii. Have an overview of the general requirements, use and current status of the supply of oxygen.

The assessment identified key hindering factors: (i) insufficient supply of medical oxygen, (ii) inadequate human resources and capacity of technical staff, (iii) poor repair and maintenance practices, (iv) poor hypoxemia diagnosis, (v) lack of sufficient distribution systems i.e., cylinders, manifold and pipeline networks, (vi) variations in available resources, with larger gaps in the lower-level facilities. For example, 53% of health facilities had a pulse oximeter, whereas 82% of district and 95% of tertiary hospitals had a pulse oximeter, (vii) power supply can be irregular.

1.1 Oxygen Supply Capacity and Structure in Tanzania - A Situation Analysis

A model[1] for determining oxygen need predicts that 29,583 litres of oxygen is needed every minute to meet the demand of all health facilities with beds in Tanzania. In the assessment in 2020, Tanzania had the capacity to generate only 16,036 litres per minute (LPM), resulting in a supply gap of 13,547 LPM as demonstrated in Figure 1. The true need is likely much higher because the above estimate is constrained by the number of available beds for patients.

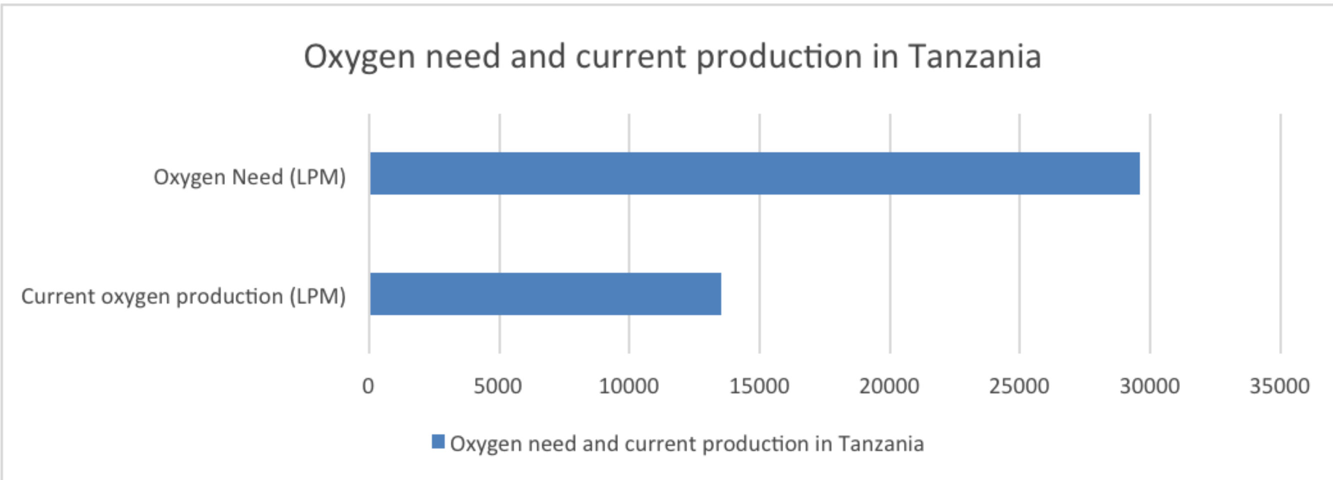


Figure 1: Supply of oxygen in Tanzania and estimated need in 2020

While the oxygen supply already falls short of the need by a significant amount, the true oxygen gap is likely much larger. Oxygen production in Tanzania is only partially used for medical purposes; a large portion goes to industrial customers. Distribution limits further constrain the supply; oxygen availability is limited in more remote regions as suppliers are often unwilling or unable to deliver to some locations.

Furthermore, estimates show a large gap in oxygen delivery equipment and personnel. The estimated number of oxygen concentrators in Tanzania only provides a small fraction of the estimated oxygen need. Oxygen cylinders are also too few to meet demand. Lastly, beds with an adequate number of trained providers equipped to provide critical care are limited. This would be a major limitation to providing oxygen therapy even if sufficient equipment and supplies were available.

[1] A standard industry model used by PATH estimated oxygen need based on the available beds in Tanzania. The number of facilities and average total beds per facility for health centers, district hospitals, regional, and specialized hospitals were calculated from the Tanzania Master Health Facility List, totaling 65,465 beds. Bed counts by type within district, regional, and specialized hospitals were then calculated using approximate bed distributions per facility: general (80%), added services (15%), and critical care beds (5%). These bed counts were used in the Quantification and Costing Tool with default assumptions of bed occupancy rate (70%) for all beds, to generate an estimate of total baseline oxygen consumption. The rates of oxygen consumption for each bed type are assumed to be: general beds- 0.5LPM, added services beds- 1 LPM, critical care beds- 5 LPM.

Oxygen therapy costs approximately 0.23cents (USD) per litre, and treating a patient with a severe respiratory infection with oxygen costs approximately $28 if they have low-need (2L/min for 2 days), $258 if high-need (10L/min for 5 days) and $1,074 if they need mechanical ventilation (30L/min for 7 days).

1.2 Scale-up Strategic Framework

Since 2020, the Government, through MoH, in collaboration with global health donors and development partners have implemented several initiatives to improve the availability and accessibility of oxygen supply as a strategic achievement towards universal health coverage (UHC).

The ongoing initiatives to improve the availability of medical oxygen in Tanzania include the following:

- Installation of seven (7) 50Nm³/h oxygen plants capable of filling up to 200 cylinders at regional referral hospitals, and plants are in the process of installation to a total of 54 oxygen generating plants.
- Installation of medical oxygen pipeline systems in some of the regional referral hospitals.
- Increasing supply of oxygen cylinders, oxygen-monitoring devices including pulse oximeters and patient monitors, portable oxygen concentrators, oxygen delivery interfaces to various healthcare facilities.
- Providing capacity building of healthcare professionals including clinicians, nurses and biomedical engineers.

1.2.1 Vision

A comprehensive scale-up plan for medical oxygen systems is effectively implemented to ensure availability, accessibility, and affordability of quality medical oxygen therapy to meet universal health coverage in Tanzania

1.2.2 Objectives

- To improve data collection and utilization to determine the gaps in medical oxygen systems for better planning, advocacy and financing
- To improve availability of quality medical oxygen systems and monitoring devices for better diagnosis and treatment outcomes
- To develop operational guidance for short and long-term scaling up plan based on sustainability, transparency, and cost-effectiveness
- To ensure the requirements for Planned Maintenance Optimization (PMO) such as maintenance workshops, equipment testing, working tools, spare parts, consumables and Personal Protective Equipment (PPEs) are available and effectively utilized.

1.3 Current Barriers to Access

The results of the assessment revealed several shortfalls, which were then categorized into task groups as listed below.

1.3.1 Production Barriers

- Inadequate funding for sustainable long-term investment in procurement, installation, operations and safeguarding of medical oxygen systems. For example, some of the 7 PSA plants installed in February 2020 have been operating below capacity or have been non-functional due to insufficient funds for the appropriate technology, installation, commissioning and maintenance.
- Insufficient baseline data of the existing capacity at the country level, therefore difficult to quantify the requirements for justification of a huge investment in medical oxygen supply systems.
- Absence of a clearly defined goal and roadmap, hence difficult to leverage the opportunities for improvement and optimization of supplemental oxygen therapy.
- Financial and economic factors- as most of the large capital investments rely on support from donors (including procurement of high quality medical oxygen systems), it is difficult to plan and budget appropriately.

1.3.2 Transportation and Distribution Barriers

- Complex supply chain of medical oxygen from the refilling centre to healthcare facilities requires special storage and transportation facilities. This entails special tankers for transporting oxygen tanks and cylinders to prevent leakages and damaging the valves.
- No country database for quantification of the required amount of oxygen supply at a healthcare facility level.
- Variation in geographical production and distribution of medical oxygen across the country increases the costs of refilling and transportation thus increasing the treatment costs of supplemental oxygen.

1.3.3 Storage and Supply Barriers

- Frequent prolonged stock-out episodes due to poor planning, prioritization, inventory control and forecasting of requirements
- Lack of or poor infrastructure for oxygen distribution from production source to patient's outlets e.g., manifolds units and medical gas piping systems.

1.3.4 User and Caregivers Barriers

- Inadequate knowledge among healthcare providers to diagnose hypoxemia and administer oxygen therapy, contributing to underutilization and inappropriate use of oxygen devices
- Misconceptions of oxygen therapy held by some caregivers and patients- the initiation of oxygen therapy is seen as a key milestone in the disease trajectory and symbolizes declining health.
- Healthcare providers are unfamiliar with the safe use of oxygen equipment and are often not aware of when maintenance is required.
- Lack of knowledge and skills among health workers, inadequate supply of trained health workers, and a lack of in-facility processes and routines for the safe and quality provision of the essential emergency and critical care required by oxygen-requiring patients

1.3.5 Maintenance Barriers

- Inadequate maintenance-related management structures to ensure routine quality care of oxygen devices leading to deterioration and poor performance of devices resulting in a low return on capital invested.
- Health managers often do no prioritize preventative maintenance and maintenance of resources or lack the flexibility to change the process to do so.
- Budget for maintenance is almost always precarious to support procurement, installation and maintenance of medical oxygen systems in its entire lifecycle.
- Availability of competent staff to run HCTS in hospitals is another challenge. In some of the hospitals where there are one or two maintenance technicians, commonly they are overwhelmed with tasks. Chances of acquiring more staff in the near future are not apparent taking into consideration the current gap in clinical and supportive staff at all levels of healthcare. Moreover, the available technicians commonly have unreliable systems for acquiring spares and supplies, often lacking working tools and test equipment.
- Instability and frequent interruption in power supply increases the costs for purchasing stabilizers and backup power suppliers, which impacts the overall cost of oxygen production.

1.3.6 Implementation Barriers

- Lack of a national coordination mechanism to define the flow of information, coordinate activities, and monitor progress for improvement.
- Lack of standardized specifications list of medical oxygen systems hence introduction of multiple varieties of technology, which is difficult to manage and maintain, and purchasing of substandard equipment.
- Lack of national guidelines for the effective use of oxygen and the safe and quality provision of the essential emergency and critical care required by oxygen-requiring patients

Table 1: The key SWOT factors in scaling up oxygen systems in Tanzania

Strength	Weakness	Opportunities	Threat
Availability of oxygen subcommittee and relevant stakeholders to facilitate the scale-up plan	Uncoordinated common goal for improving the availability and accessibility The ongoing activities for improving the supply and accessibility are not harmonised.	Support from WHO, Global Fund, financial institutions, and other partners to aid country initiatives for improving access to oxygen production and supply	High investment cost of oxygen systems and commitment to put oxygen at the centre of strategies for universal health coverage, hence limited available resources need to be well managed and coordinated
Review progress of the scale-up plan from production, supply, and use of oxygen	Absence of baseline data about the existing capacity at country level. Absence of a sustainable management plan and guidelines for oxygen systems infrastructure.	Deciding on large scale investment for oxygen systems can help generate economies of scale hence drive down investment costs for medical oxygen systems	High investment costs and commitment to put oxygen supply systems at the centre of strategic for universal health coverage
Availability of the estimated quantity and costing of improving the supply in the country	Malfunction of the existing oxygen systems including monitoring equipment due to lack of maintenance and specialized test equipment No production or supply uniformity across the country	Medical oxygen systems are currently recognised as a cost-effective investment at all healthcare levels as part of improving quality of healthcare	Lack of proper logistics in sourcing the required technical support, spares, and consumables

2.0 Medical Oxygen Systems

Medical Oxygen Systems encompass many components- from the production source to the outlets points including patient monitoring. The medical oxygen system specifications (ANNEX 1) indicate the recommended size for healthcare facilities. The technical flow of the oxygen system’s parameters and their relationships are as shown in figure 2.

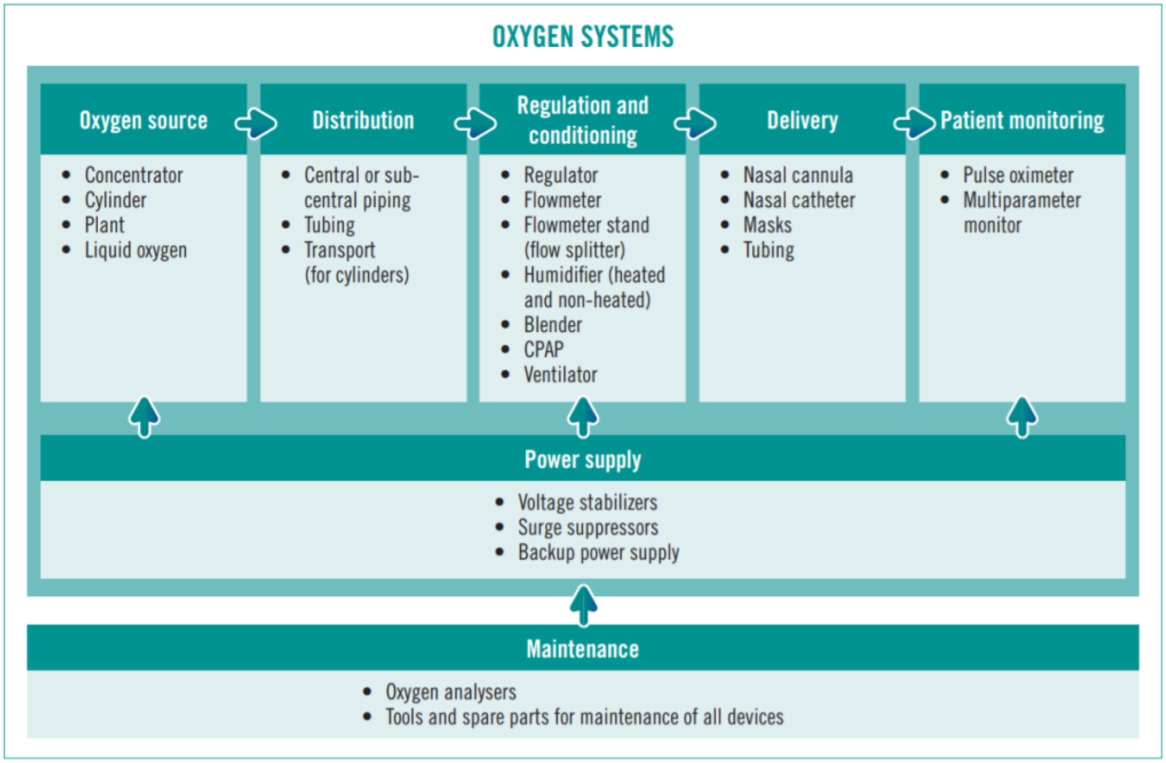


Figure 2: Flowchart of oxygen system components, (WHO-UNICEF 2019)

2.1 Sources of Medical Grade Oxygen

Medical oxygen is differentiated from industrial oxygen due to regulatory compliance requirements on the composition, concentration, safety and practice to avoid the possibility of particulate and microbial contamination.

In practice, oxygen is obtained from the atmosphere containing 21% of the total atmospheric air. The two most widely used methods for oxygen production are Cryogenic Air Separation (CAS) and Pressure Swing Adsorption (PSA) as described below.

2.1.1 Cryogenic Air Separation (ASU) Unit

Under this process oxygen is separated from other gases by liquefying air at a low temperature. Liquid oxygen (LOX) has a boiling point (BP) of –183°C, therefore a special storage system consisting of a cryogenic storage tank like a vacuum bottle is used to maintain the temperature below boiling point (David R.Vinson, 2006).

It can either be stored in bulk tanks or transported in cryogenic tankers to onsite Vacuum insulated evaporator (VIE) systems where the liquid product is converted to gaseous form via ambient air vaporizer.

LOX has the following advantages over medical oxygen in gas form:

- The purity of oxygen from this source is 99.5% v/v of oxygen. Moreover, the purity is constant, and does not vary with flow. This also makes it ideal for use with ventilators and critical ICU beds.
- There are no operational costs associated with LOX administration. Once it is filled into the tank inside the hospital premises, it flows into the Medical Gas Pipeline System (MGPS) of the hospital, on its own, (once the valve is opened). No extra labour, no electrical power, no maintenance is required.
- LOX has no limitation of Flow Rate. It simply supplies at whatever flow rate is required at any given point in time. With other sources of oxygen, the concentration drops or may even fail if the flow required exceeds the flow rate of the oxygen source.
- The storage capacity of LOX is large. One litre of LOX is equivalent to 798 litres (0.798Nm³) of gaseous Oxygen. Therefore, liquid storage is less bulky and less costly than the equivalent capacity of high-pressure gaseous storage.

Despite the above-mentioned advantages, the following are limitations with LOX:

- Cryogenically produced liquid oxygen is always generated off-site (not at a medical facility), hence the use of LOX relies on external supply chain mechanisms and needs a bit more caution with respect to transport and storage due to the risks associated with higher pressures and low temperature. Extra care should be taken in more extreme environments.

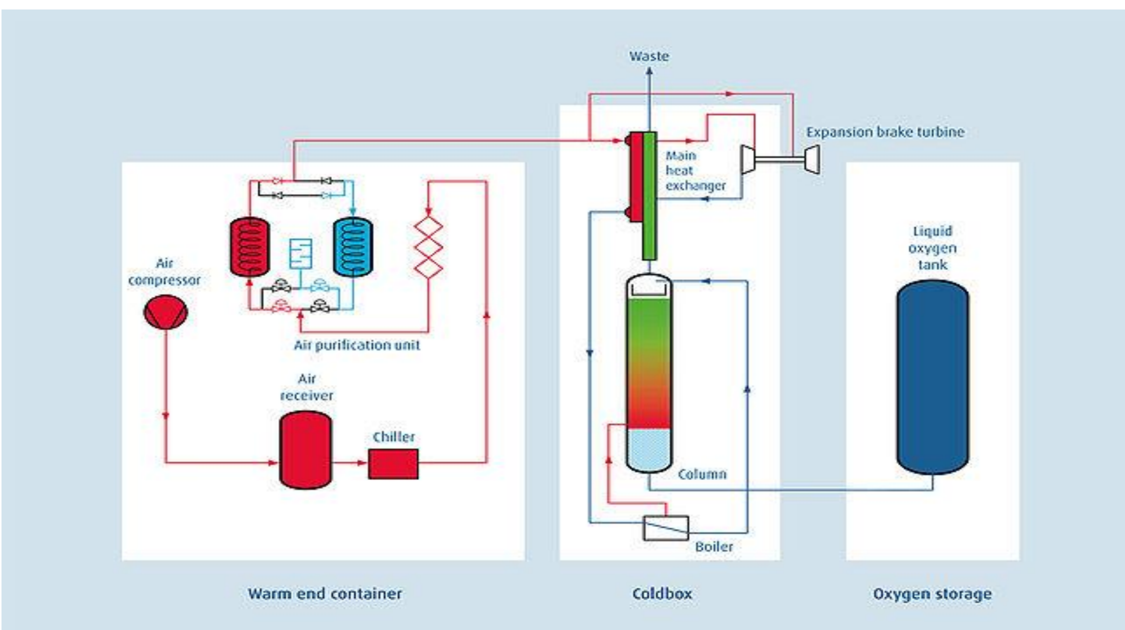


Figure 3: Cryogenic air separation plant

2.1.2 Pressure Swing Adsorption (PSA) Plant;

This is a process where oxygen is generated from compressed air through an adsorption method. Dried compressed air is allowed to flow through a zeolite molecular sieve, which retains nitrogen resulting in high purity oxygen gas as a by-product at 93% ± 3% purity (Riboldi et al. 2017).

This method has become a cheap and viable alternative to cryogenic air separation and is the same technology used in small-scale oxygen production such as mobile oxygen concentrators.

Oxygen from a PSA plant can either be piped directly to bedside terminal units within patient areas or with a booster compressor to refill cylinders for oxygen distribution. Oxygen plants require a reliable source of power.

PSA plants have the following advantages compared to ASU plants:

- Oxygen generation process is an extremely clean operation since it involves atmospheric air as a raw material allowing oxygen to pass through the system while exhausting back nitrogen to the environment.
- PSA plant operates at low pressure normally between 4 – 8bars (g) minimizing the risk of explosion
- The PSA process is continuously repeated to provide an uninterrupted supply of oxygen at purity levels between 92-95% oxygen.
- Low total cost of ownership when lifecycle cost analysis (which includes all the costs incurred from acquisition through disposal at the end of a plant's useful life) is compared to ASU plants

Since every technology comes with pro and cons, the operations of PSA oxygen generation plants have the following disadvantages:

- This technology is best suited for smaller volumes of oxygen production, typically approximately flow-mass maximum of 300 tons per day
- Oxygen production is largely controlled by the bed size, hence the costs rises linearly when a high volume of oxygen production is required.
- PSA plants require substantial preventive maintenance and repairs to keep them functioning that must be considered in the overall planning and budgeting.

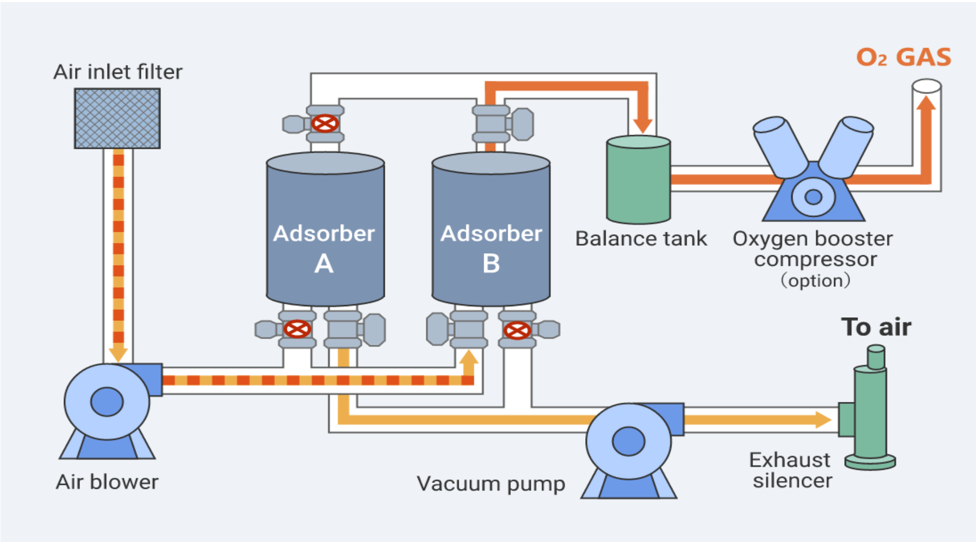


Figure 4: Pressure swing adsorption plant with refilling oxygen booster

2.1.3 Oxygen Concentrator

This is a PSA technology, self-contained, electric powered and point-of-care device designed to concentrate oxygen from ambient air, removing the nitrogen to produce a continuous source of more than 90% concentrated oxygen. It should not be used if the oxygen concentration falls below 82%. Most of the concentrators can deliver maximum flow rates between 5lpm to 10lpm through single or dual flowmeters and work best in environments with clean air, low humidity, and reliable electricity (Erwan d'Aranda et al 2016).

Point-of-care oxygen concentrators usually don't have batteries, so power back up is a crucial consideration. Without a backup there is a risk of a power outage ending the oxygen supply, which could be catastrophic for the hypoxic patient. They also do require regular preventive maintenance to ensure proper functioning.

Supply of oxygen to patients can be shared to multiple patients through use of a splitter, but only for the patients who require lower flow rates. It is best practice to also have cylinders as a backup supply.

2.2 MEDICAL OXYGEN STORAGE AND SUPPLY DEVICES

2.2.1 Definitions:

i) Medical Oxygen Manifold: a system device that decompresses several oxygen cylinders after they are grouped together and then transports oxygen gas through the main gas pipeline to the user terminal.
   Oxygen Automatic Manifold is mainly suitable for continuous consumption of bottled oxygen.
ii) Portable liquid cylinder: A vacuum insulated cryogenic container used for the storage of liquefied gases having a maximum allowable working pressure of greater than 0.5 bar and the capacity normally not exceeding 500 litres.
iii) Medical Gas cylinder: A term that is commonly used to describe a pressurized, re-inflatable container at a working pressure of 150bar/200bar and tested at a pressure of 250bar. Cylinders are used for storage and transportation of medical gas. The most commonly used medical oxygen cylinders under BS Standard are summarized in the table 2:

Table 2: Medical Gas Cylinder Data Table

Type	Material	Water Capacity (lts)	Content Capacity (lts)
D	Steel and Aluminium	2.3	340
E	Steel and Aluminium	4.7	680
F	Steel and Aluminium	10	1360
G	Steel	23.4	3400
J	Steel	47.2	6800

According to Srivastava, Uma (2013) Medical gas cylinders were traditionally constructed of low carbon steel, now they are constructed of lightweight chrome molybdenum steel, aluminium or a composite (such as aluminium wrapped in carbon fibre). Special cylinders made from aluminium are useful in magnetic resonance imaging (MRI) rooms.

iv) Primary source of supply: That portion of the supply system which supplies the pipeline distribution system
v) Secondary source of supply: That portion of the supply system which supplies the pipeline distribution system in the event of exhaustion or failure of the primary supply
vi) Reserve source of supply: That portion of the supply system which supplies the complete, or a portion, of the pipeline distribution system in the event of failure or exhaustion of both the primary and secondary sources of supply

For a healthcare facility, medical oxygen supply should have a primary and secondary supply whereby each supply can be a combination of the following systems:

i) Direct supply from the generator
ii) Gas in cylinders
iii) Cylinder bundles connected to a manifold system
iv) Portable liquid cylinder
v) Cryogenic liquid in stationary vessels

The segments used for medical oxygen supply and distribution are summarised in the table 3, whereas the segments for oxygen administration, which refers to the use of highly concentrated medical oxygen for treatment in respiratory care are summarised in the table 4.

Table 3: Segments for Medical Oxygen Supply and Distribution

NO	Supply system Information	Advantages	Disadvantages
1	Liquefied oxygen supply -The systems involve a vacuum insulated evaporator where cold liquid oxygen is stored in bulk. -The reservoir may be a permanent installation or portable, lightweight container. In normal operation, the liquid oxygen flows out through an ambient vaporizer causing it to turn into the gaseous form, which is then delivered through pressure regulator to the distribution line (Hardavella et al. 2019).	It is less bulky and less costly (i.e. supplied in a relatively small and lightweight container). -It has a high oxygen purity at 99% v/v which does not vary with flow,	-Refilling portable tank requires special skills and large tanks require a large space for a filling tanker -Liquid oxygen cannot be stored for extended periods of time as it evaporates and builds up pressure inside the storage tank. -Liquid oxygen is more expensive than compressed gaseous oxygen.
2	Centralized Oxygen Gas Supply Centralized medical gas from an	-Minimizes the use of oxygen cylinders at	-High investment cost for the construction of

	oxygen gas source directly to outlets at the delivery point through a pipeline system.	bedside and maintains a clean environment from contamination caused by movement of cylinders. -Uninterrupted and clean gas supply at desired location. -Instant availability of clean, safe and reliable delivery of gas	pipeline network -Requires backup or redundancy in the event of system failure.
3	<u>High pressure cylinders</u> -Oxygen from a cylinder is transmitted either directly to the patient or to the distribution line through a pressure regulator with flowmeter. -The patient is administered oxygen through breathing devices (a mask or cannula) and a long tube connecting from oxygen outlet to the breathing devices.	-No warm-up time required to provide oxygen therapy -Do not require power supply -Can be used directly to the patient -Minimal maintenance -Oxygen flow doesn't affect the concentration	-Heavy, difficult to transport -High pressure vessel, need to be handled with care -Need regular refilling from a refilling station and is costly to transport -Need to be connected to pressure regulators and flowmeters
4	<u>Manifold Unit</u> Medical gas manifolds are designed to supply the correct pressure and volume of gas from gas cylinders or tanks to a healthcare facility's pipeline system Cylinders are arranged in primary group and secondary group whereby a pressure transducer switches to the secondary manifold once the pressure in the primary group drops below a certain limit	Allows continuous flows of oxygen even when individual cylinders are empty.	-Needs high capital investment to design, supply, install and commission

Table 4: Segments for Accessories for Medical Oxygen Therapy

NO	Supply system Information	Advantages	Disadvantages
1	<u>Oxygen Flowmeters with humidifier</u>	It controls the volume	

	Oxygen flowmeter is the device used to regulate the flow of oxygen. It consists of a gas pressure gauge, pressure reducer, safety valve, flow control valve and humidification bottle.	of humidified oxygen given to the patient	
1	<u>Nasal-cannula (low-flow system)</u> Nasal cannulas consist of a small-bore tube connected to two short prongs that are inserted into the nares to supply oxygen directly from a flow meter or through humidified air to the patient. It is used for short- or long-term therapy (i.e., COPD patients), and is best used with stable patients who require low amounts of oxygen.	-Can provide 24% to 40% O_2 -It is convenient as patient can talk and eat while receiving oxygen. -Easy to use, low cost, and disposable.	-May be drying to nares if level is above 4 L/min.
2	<u>Face mask</u> A mask that fits over the mouth and nose of the patient and consists of exhalation ports (holes on the side of the mask) through which the patient exhales CO_2 (carbon dioxide). These holes should always remain open. The mask is held in place by an elastic around the back of the head, and it has a metal piece to shape over the nose to allow for a better mask fit for the patient. Humidified air may be attached if concentrations are drying for the patient.	-Can provide 40% to 60% O_2 concentration. - Used to provide moderate oxygen concentrations. Flow meter should be set to deliver O_2 at 6 to 10 L/min.	-Difficult to eat with mask on. -Mask may be confining for some patients, who may feel claustrophobic with the mask on. -Requires flow rates of at least 5l/min.
3	<u>Non-rebreather mask (high-flow system</u> Consists of a simple mask and a small reservoir bag attached to the oxygen tubing connecting to the flow meter. With a non-rebreather mask, there is no re-breathing of exhaled air. It has a series of one-way valves between the mask and the bag and the covers on the exhalation ports. On inspiration, the patient only breathes in from the	-With a good fit, the mask can deliver between 60% and 80% O2 concentration**.** - Flow rate must be high enough to ensure that the reservoir bag remains partially inflated during inspiration.	-These masks have a risk of suffocation if the gas flow is interrupted, the bag should never totally deflate. -The patient should never be left alone unless the one-way valves on the exhalation ports are

	reservoir bag; on exhalation, gases are prevented from flowing into the reservoir bag and are directed out through the exhalation ports.	The flow meter should be set to deliver O_2 at 10 to 15 L/min.	removed. -The mask also requires a tight seal and may be hot and confining for the patient. -The mask interferes with talking and eating.

2.3 Oxygen Therapy Diagnostic and Monitoring Devices

Hypoxemia is defined as low levels of oxygen in the blood. It can be caused by respiratory infections (pneumonia, bronchiolitis) as well as many other conditions such as sepsis, severe malaria, status epilepticus, trauma, obstetric and neonatal conditions (respiratory distress, apnoea, asphyxia, sepsis). Being a common complication of severe diseases, hypoxemia can lead to organ failure and increases the risk of death by up to seven times. A hypoxemic patient will have an oxygen saturation of <94%, whereas a healthy patient inspiring air at sea level should have an arterial oxygen saturation of 95-99% (WHO, 2016).

Oxygen therapy, also known as supplemental oxygen, involves the provision of concentrated oxygen to hypoxemic patients in order to restore oxygen levels to normal. Like other medicines, medical oxygen is a prescription drug.

Consequently, a reliable supply of quality oxygen and prompt diagnosis of hypoxemia by skilled healthcare personnel are critical for effective hypoxemia management.
The devices for diagnosis and monitoring of oxygen concentration are summarised in table 5.

Table 5: Oxygen Monitoring Devices

No	Device	Description	Remarks
1`	Arterial Blood Gas (ABG) Analyser 	An ABG is a blood test which is used to give an indication of ventilation, gas exchange and acid-base status. It is taken from an arterial blood supply to measure the levels of oxygen and carbon dioxide as well as the acidity (pH) of the blood as important indicators of lung function.	ABG is the gold standard for the diagnosis of hypoxemia. However, it is an invasive procedure requiring a blood sample and special skills to operate and an expensive analyser. It provides results at a specific moment in time.
2	Pulse oximeter <u>Types</u>	This is an indirect measurement/ estimation of oxygen saturation	In contrast to the ABG, pulse oximetry is non-invasive

	i) Fingertip  ii) Hand-held  iii) Benchtop 	of haemoglobin. It uses a sensor attached to the person's finger or earlobe	procedure. Depending on the type of pulse oximeter used, continuous measurement of the blood oxygen concentration can be recorded.
3	Patient Monitor 	This device uses multiple sensors and electrodes for monitoring physiological signals. In addition to oxygen saturation, it can measure the ECG, respiratory rate, invasive blood pressure, non-invasive blood pressure and body temperature.	Available in different sophistications including non-invasive and invasive types. Can be substantially more expensive than a pulse oximeter.

3.0 NATIONAL MEDICAL OXYGEN DEMAND

The National demand for medical oxygen supply has dramatically increased especially during wave seasons of COVID-19 and may rise further due to increased respiratory complications. Therefore, proper quantification of oxygen therapy requirements is necessary. (Rakesh V et al. 2021).

The actual demand for oxygen supply could be established by determining the available gap as illustrated below:

Quantification of the requirements; Need gap = demand – baseline supply capacity

= 29,583 litres/min - 16,036 litres/min

Based on the available need gap of 13,547 litres/min

In litres per hour: 13,547 L/min * 60 min/hr = 812,820 L/hr

In cubic meters per hour: 812,820 L/hr *1m³ /1000 L = 812.82m³ /hr

Volume required in cubic meters per day: 812.82m³ /hr * 24hrs = 19,507.68m³/day

The Volume Capacity of a recommended type J cylinder is 6.8m³ of oxygen gas

Therefore, refilling of type J cylinder in a day = 19,507.68m³/6.8m³ = 2869 number of cylinders

This implies, if only refilling cylinders are used:

- *For a PSA oxygen plant with the capacity to refill 200 type J cylinders = 15 additional PSA Oxygen Plants are required*
- *For a PSA oxygen plant with the capacity to refill 100 type J cylinders = 29 additional PSA Oxygen Plants are required*

3.1 Recommended Intervention for optimizing oxygen access and reliability

For effective implementation of the oxygen systems scale up, the following are recommended interventions:

3.1.1 Conduct a thorough technology needs assessment countrywide

A country needs assessment is required to determine the available gaps and priority settings of the resources.

The assessment will inform on the following key areas:

- Needs requirements with reference to the standard requirement (refer TMDA Guidelines)
- Geographic distribution of the need, existing capacity, and quantification of the requirements
- Establishing the existing service baseline data to help guide service development, redesign and measure future progress

From these three components, health care planners and commissioners, together with other stakeholders, can determine the policy direction they wish to pursue.

There can also be other objectives including:

- Improving access and equitable allocation of resources at local, regional and national levels;
- Targeting resources at area(s) of highest need;
- Securing the active participation of key stakeholders and players in understanding the need for change and how it can be achieved.

3.1.2 Selection of the appropriate technology of medical oxygen supply systems

The appropriate choice(s) of oxygen source depends on many factors, including the amount of oxygen needed at the treatment centre; the available infrastructure, cost, capacity, and supply chain for local production of oxygen; the reliability of electrical supply; and access to maintenance services, consumables, and spare parts. Details of the most common sources of oxygen (liquid oxygen plants, oxygen PSA plants, oxygen concentrators) are included, and in more depth in WHO-UNICEF technical specifications and guidance for oxygen therapy devices.

i. PSA oxygen plants Liquid oxygen plants

Cryogenically produced liquid oxygen is commonly generated off-site (not at a medical facility). Medical facilities can be equipped with large bulk liquid oxygen tanks that are refilled periodically by a truck from a supplier. The liquid oxygen tank supplies a centrally piped system throughout the health facility by self-vaporization and for which a power supply is not required.
Under this option, the liquefied plants can be installed at a geographical center of the zone namely: Costal Zone, Northern Highland Zone, Lake Zone and Central Zone equipped with all the facilities for refilling, storage and distribution of LOX to serve their service areas.
It is best practice to have cylinders as a backup supply.

ii.

A pressure swing adsorption (PSA) oxygen plant serves as a large, central source of oxygen generation using PSA technology like concentrators that can be located on-site at medical facilities.
Oxygen from a PSA plant can be piped directly either to bedside terminal units within patient areas or, with a booster compressor, be used to refill cylinders for oxygen distribution (either on-site or to neighbouring health facilities) or for oxygen sources and distribution to treatment centres.
It is best practice to also have cylinders as a backup supply.

iii. Oxygen concentrators

Oxygen concentrators are portable and can be moved between clinical areas, but they are also often set up to be stationary fixtures in patient areas. Concentrators designed for portable medical support are available in models that can deliver maximum flow rates of between 5 and 10 L/min.
When used with a flowmeter stand for splitting flow, concentrators can provide a continuous supply of oxygen to multiple patients at the same time. Concentrators can provide a safe and cost-effective source of oxygen, but they do require a source of continuous and reliable power and regular preventive maintenance to ensure proper functioning. Especially for smaller health facilities that do not require much oxygen, bedside oxygen concentrators can provide a good and pragmatic form of reliable oxygen therapy. It is best practice to also have cylinders as a backup supply.

iv. Oxygen storage cylinders

Oxygen can be compressed and stored in cylinders as liquefied oxygen or in gas form and then transported to health facilities. Cylinders can be used either by:

- installing them directly within patient areas similar to direct piping
- Connecting them to sub-central manifold systems (groups of cylinders linked in parallel) at the facility.

Thus, when cylinders are the primary source of oxygen in a health facility, a strong supply-chain is required to ensure ongoing availability. Once filled, cylinders themselves do not require electricity, but they do require several accessories and fittings to deliver oxygen, such as pressure gauges, regulators, flowmeters, and in some cases, humidifiers.

Cylinders also require periodic maintenance of the valve and hydrostatic pressure testing for strength and leakage.

Additionally, storage or transportation of medical oxygen in cylinders has to be carefully done and by trained personnel as the contents are under extreme pressure.

v. Pipeline intra-hospital distribution networks

Pipeline intra - hospital distribution networks are helpful to supply oxygen at high pressure to equipment such as Anaesthetic machines and ventilators.

A key advantage of pipeline systems is that they obviate the need for handling and transporting heavy cylinders between hospital wards. However, the high cost and complexity of installing centralized oxygen sources with copper pipelines and the associated specialized maintenance required for this make pipeline systems less accessible for turnkey installations

3.2 Implementation Stages

Implementing a program for scaling up oxygen supply is a multifaceted process, which requires the engagement of relevant internal and external stakeholders in the healthcare sector including Government Departments and agencies, healthcare management teams, healthcare workers and maintenance staff, under the following implementation stages:

i. To revise and strengthen national policy and program guidelines and standard operating procedures (SOPs) for medical oxygen production, distribution, and use.
ii. To develop a well-defined national roadmap to include strategic planning, advocacy, resource mobilization for strengthening oxygen systems.
iii. To strengthen the procurement process by defining key steps to be followed to ensure acquisition of appropriate and cost-effective technology including installation and commissioning and conditions for after sales support.
iv. To develop national guidelines for the effective use of oxygen and the safe and quality provision of the essential emergency and critical care required by oxygen-requiring patients
v. To develop training modules, organise and deliver training programs to healthcare providers and maintenance team on administering of oxygen gas, use of monitoring devices and oxygen equipment and maintenance of medical oxygen systems including use of specialised test equipment, the effective use of oxygen and the safe and quality provision of the essential emergency and critical care required by oxygen-requiring patients
vi. To establish a sustainable financial system to meet the goals set in the roadmap
vii. To develop and implement monitoring and evaluation framework

3.3 Focusing Areas for Oxygen Systems Scaling-up

Members of the stakeholders meeting from country health service delivery systems starting from the Primary Health Care level to the National Hospital level, MoH, PO –RALG and Ministry of Finance and Planning identified the following key areas of focus for the recommendations to be drawn:

1. Oxygen production at scale

2. Transportation and supply
3. Equipment maintenance and sustainability
4. Clinical use of oxygen
5. Oxygen Supply Coordination
6. Monitoring & Evaluation

4.0 OXYGEN PRODUCTION

Aim

- To provide a national strategic framework to guide scale up of medical oxygen supply and utilization.
- To have a sustainable production system of medical oxygen which is sufficient, reliable, and safe for therapeutic purposes towards a universal health coverage (UHC).

Table 6: Proposed Investment

Health Facility	Proposed investment	Rationale/Justification
PHC		
Dispensary	Supply and installation of type J oxygen cylinders and wall mounted cylinder rack and use of concentrators for secondary supply	Low demand and absence of admission services
Health centre	Installation of a pipeline system supplied from a manifold unit with 10 oxygen cylinders for primary supply and use of oxygen concentrators for secondary supply	Admission and operating theatre, *a need for back-up and alternative source for any fault.*
DH	Install oxygen plant in strategic councils, Install piping system supplied from a manifold unit with 10 oxygen cylinders and use of oxygen concentrators for secondary supply	Admission, operating theatre, high level of cases and referral point for HC
RRH	Install oxygen plant for primary supply, install pipeline system supplied from a manifold unit with 20 oxygen cylinders. Plant should be able to produce and refill gaseous oxygen cylinders	Receiving complex cases, large operating theatre compared to DH, presence of ICU and Emergency Department
ZRH	Install oxygen plant for primary supply; install pipeline system supplied by a manifold unit with 20 oxygen cylinders. Plant should be able to produce and fill in type J cylinders gaseous oxygen	Receiving complex and high volume of cases, large operating theatre compared to RRH, presence of ICU, High Dependent Unit (HDU) and Emergency Department
Specialized Hospitals	Install oxygen plant for primary supply, install of pipeline system supplied from a manifold unit with 20 oxygen cylinders. Plant should be able to produce and fill in type J cylinder gaseous oxygen. Use of liquid oxygen (LOX) tank for	Receiving special medical cases, low volume of cases, presence of HDU and Emergency Department

	secondary supply	
National Hospital	Install oxygen plant for primary supply, install pipeline system supplied from a manifold unit with 20 oxygen cylinders. Plant should be able to produce and fill in type J cylinder gaseous oxygen. Use of liquid oxygen (LOX) tank for secondary supply	Receiving more complex cases compared to all other levels, advanced and large operating theatre compared to all other levels, presence of ICUs, High Dependent Units (HDUs) and Emergence Departments

4.1 Special Considerations for Oxygen Production Investment

1. DH, which is in *hard-to-reach areas* (geographically), is recommended to install plants accompanied with all features noted in ***Table 6.***

The recommended capacity of an oxygen plant for a District Level Hospital is a PSA Oxygen Plant with a refilling capacity of 100 type J cylinders per day.

2. Specialized Hospitals with high *demands of medical oxygen* due to its specialty services should follow RRH oxygen requirements.
   For Regional Referral Hospitals, Zonal Hospitals and National Hospitals, the recommended plant is a PSA Oxygen Plant with capacity to refill 200 type J cylinders per day

3. Incentivize the engagement of the private sector in oxygen production value chain.

5.0 MODES OF TRANSPORT OF MEDICAL OXYGEN PRODUCTS

Transportation of medical oxygen may be hazardous if legal safety requirements are not met. This includes compliance to rules guiding the transportation of medical gas pressure equipment, adherence to SOPs and involvement of trained staff.

The following are the key aspects for consideration in transportation of medical oxygen:

1. Transportation will involve filled high-pressure oxygen cylinders. This will require the use of well-designed trucks meeting the standards/specifications as per the country regulatory recommendations (e.g., TMDA guidelines regarding oxygen cylinder transportation).
2. Transportation of liquid oxygen from generation points (Zones) to the Healthcare facilities will require use of liquid oxygen tank trucks

5.1 Medical Oxygen Supply to point of care

Oxygen, irrespective of the mode of administration, should be accompanied with healthcare worker orientation or mentorship on oxygen use and safety management. Design requirements for the appropriate technologies, centralized systems and medical pipeline networks should be considered based on the size and location of the healthcare facility.

6.0 MEDICAL EQUIPMENT MANAGEMENT (MEM) AND SUSTAINABILITY

Aim: To ensure that equipment used for production, storage, supply and distribution, treatment and monitoring of supplemental medical oxygen are safe, available, accurate, and affordable over their useful lifetime.

6.1 Medical Equipment Management (MEM) Plan

MEM is defined as controlling, monitoring and maintenance of medical equipment in order to keep the equipment and systems running efficiently over their useful lifetime.

MEM activities consist of the following activities:

- Developing policies and guidelines for planning, selection, acquisition, utilization, safeguarding and disposal of medical equipment.
- Gathering reliable information about medical equipment to establish baseline data.
- Conducting technology needs assessments to identify the available gaps.
- Performing activity-based costing and budgeting.
- Acquisition of technology, Installation and Commissioning
- Ensuring sufficient resources have been allocated for a continuous operation and maintenance of equipment and systems
- Organizing and conducting training to users for smooth and safe operation
- Preventative maintenance, mmaintenance and repair of equipment
- Decommissioning and disposing of technology

6.2 Implementation of Medical Equipment Maintenance System

For effective implementation of a sustainable MEM Plan for medical oxygen production and supply system, the following activities should be established.

6.2.1 Establish a Medical Oxygen Supply Management Group

Healthcare facilities should establish a medical oxygen supply management group to oversee adherence to the policies and guidelines across the organisation.

Management group should include representation from the following staff: clinicians, biomedical engineering, PMU, risk management, infection and control, IT and data support and device users.

6.2.2 Medical Equipment Maintenance and Sustainability

Medical equipment maintenance, one of the sections in the overall MEM, is responsible for safeguarding of medical equipment.

The in-house Head of Biomedical Engineering Department is responsible to ensure an appropriate maintenance system is effectively implemented and performed in a timely manner within the facility.

BME department should submit a monthly maintenance progress report of medical oxygen supply systems to the national level on the following key issues:

- Performance of equipment maintenance system, **a computerized system is mostly preferable**
- Monthly performance and condition status of medical oxygen supply systems including equipment utilization, PPM, failure cases, calibration, and certification.

6.2.3 Appointing Regional and District Health Care Technical Services (HCTS) Coordinators

Regional HCTS Coordinator

A qualified biomedical engineer or an experienced biomedical engineering technician should be employed to coordinate and supervise HCTS in the region. This person should be a member of the regional hospital management team (RHMT) to provide him/her with the necessary resources to supervise district and hospital HCTS. The role will be called 'Regional Health Care Technical Services Coordinator' and the duties are defined further below.

The roles and responsibilities of the regional HCTS coordinator

i. Advise the regional medical Officer and the RHMT on issues pertaining to Health care technology – procurement, maintenance and repair of medical equipment, infrastructure, and electricity supply, clean and wastewater.
ii. Coordinate and supervise health care technical services in the region
iii. Be a member of the regional Hospital management team
iv. Organize, coordinate, and supervise health infrastructure and equipment maintenance and repair in the regional hospital
v. Coordinate, supervise, monitor, and report on the contracted out maintenance services of the regional hospital
vi. Supervise twice yearly updating of inventory in all key function areas within the regional hospital
vii. Participate in actual maintenance and repair of medical equipment, in collaboration with the regional hospital HCTS technicians
viii. Conduct coaching and training to subordinates and health workers on issues of equipment care and user maintenance
ix. Prepare quarterly and annual health care technical services report for the region and deliver it to the Regional Medical Officer and MOHCDGEC HCTS Office
x. Prepare quarterly and annual health care technical services report for the hospital and deliver it to the Medical Officer in Charge of the regional Referral Hospital

District HCTS Coordinator

Council Health Management Teams (CHMT) will be fully responsible for maintenance of equipment and infrastructure in all health facilities in the district. Commitment of this team to maintenance is of paramount importance. The district maintenance services will be part of the prime responsibilities of the RHMT. The District Medical Officer will be the overall custodian of the HCTS services in the district.

The District Medical officer will ensure that the District Council employs and retains a qualified biomedical engineering technician to coordinate and supervise HCTS in the district. This person will be a member of the CHMT to give him/her a mandate to supervise health facilities' HCTS services. The technician will acquire a title of a 'District Health Care Technical Services Coordinator'.

Roles and responsibilities of the District HCTS Coordinator

i. Advise the District Medical Officer and the CHMT on issues pertaining to Health care technology – procurement, maintenance and repair of medical equipment, infrastructure, electricity supply, clean and waste water.
ii. Coordinate health care technical services within the district
iii. Direct the district hospital HCTS and the workshop
iv. Become a co-opted member of the district Hospital management team
v. Organize, coordinate and supervise health care equipment maintenance and repair in the district hospital
vi. Collaborate with the District Engineer to organize, coordinate, and supervise health infrastructure maintenance and repair in the district hospital
vii. Coordinate, supervise, monitor, and report on the contracted out HCTS of the district hospital
viii. Supervise twice yearly updating of inventory in all key function areas within the district hospital
ix. Participate in actual maintenance and repair of medical equipment, in collaboration with the rest of the hospital maintenance technicians
x. Conduct coaching and training to subordinates and health workers on issues of equipment care and user maintenance
xi. Prepare quarterly and annual health care technical services report for the district and deliver it to the District Medical Officer who in turn will deliver it to the Regional Medical Officer
xii. Establish and sustain links on maintenance with regional referral workshop, regional HCTS coordinator and fellow district coordinators

6.2.4 Establishing and updating inventory of all medical equipment

Healthcare facilities should have an updated database of medical oxygen equipment documented in the medical equipment management plan.

The in-house Biomedical Engineering Department will be responsible for assessing all equipment. A system for inclusion in inventory and maintenance plans should cover the following:

- Document (or store?) records of equipment specifications: manufacturer, model, serial number, power consumption, equipment location and condition status
- Perform general safety inspection; identify malfunctions, damaged or worn items/ parts
- Perform risk-based criteria to determine high risk versus routine (non-high risk) equipment for risk ranking.
  The scoring to determine risk level (high, medium and low) should be established based on equipment functionality, clinical intervention and infection control risk.
- Document after sales services e.g. warranty period, after warranty maintenance contract with period and charges, supply of spare parts and consumables, acquisition cost, maintenance contract, manufacturer contacts etc.

NOTE:

High Risk Devices

Those devices that are used for life-support, therapeutic and diagnostic, whose failure or misuse is reasonably likely to cause injury to patient or staff or failure could have an immediate or serious impact on patient care.

Medium Risk Devices

Those devices whose failure, misuse or absence is not likely to cause serious injury to patients or staff but may have an impact on patient care.

Low Risk Devices

Those devices whose failure, misuse or absence is unlikely to result in injury to patient or staff and will have minimal impact on patient care.

6.2.5 Technical Support from Suppliers/ Vendor

The suppliers should have capacity to offer high or specialized maintenance and should be responsible to provide training first line and PPM to in-house maintenance staff. They should also be able to provide relevant information for verification of performance, safety, maintenance criteria and calibration needed to ensure the equipment are well maintained and operate properly and safely.

6.2.6 Components of Medical Equipment Maintenance

Medical Equipment has two major forms:

i) Planned Preventive Maintenance (PPM)

PPM is the maintenance work performed on medical equipment or system at a predetermined interval to maintain top functionality and to minimise the chances for breakdown or failure of the equipment.

ii) Unplanned/ Corrective Maintenance

Corrective maintenance is defined as troubleshooting to identify the cause of device malfunction and then rectify by replacement or adjustment of components or subsystems to restore normal function, safety, performance, and reliability.

In-house Biomedical Engineering Department should identify the levels of maintenance and assign the maintenance tasks to the appropriate groups based on availability of required maintenance tools and test equipment. The levels of maintenance are as follows:

- Equipment user or first line maintenance
- Maintenance done by in-house biomedical engineering department
- Manufacturer or authorized service agents
- Third party service providers

6.2.7 Courses of action for equipment maintenance

For each item in the inventory, a course of maintenance action should be developed. This is the most work intensive section. It requires accuracy and completeness as it will determine the budget and costs for maintenance including outsourcing of the item. The table below exemplifies the summarized action for each item.

Table 7: Courses of action for equipment maintenance

No	Equipment	Dept.	Work to be done	Problems to be expected	Consumables	Tools	Time	Spare parts
*1	2	3	4	5	6	7	8	9

Key

1. Serial number of the item found in the inventory
2. Name of the equipment?
3. Place, department, or unit where the equipment is currently based
4. All activities to be done on the equipment during a single maintenance event
5. Problems that may be expected according to the type of equipment
6. Supplies required for one maintenance event of this equipment e.g., grease
7. Tools that will be required to perform a maintenance on this item (this will depend on the work to be done listed in No. 4)
8. Estimated time required for one maintenance event
9. Spares required as stipulated in the equipment manual

6.2.8 Establish maintenance procedures

Determine how often maintenance services will be performed. This can be done daily, weekly, monthly, quarterly, semi-annual, and annually depending on what is deemed appropriate for each schedule, this is related to the degree of complexity of the maintenance, utilization rate of the equipment, condition of equipment, risk, and operational environment.

6.3 Medical Equipment Maintenance Documentation

6.3.1 Develop an Annual Planned Preventive Maintenance Schedule

An annual maintenance schedule should be developed to guide which maintenance activities should be done at a defined time interval. A mechanism for following up their execution should also be established to ensure it is effectively done in a timely manner.

The list of the recommended working tools and equipment are attached in ANNEX 2 and forms for following up Maintenance Schedule are attached in ANNEX4:

- Form1: Master Equipment Operational Checklist for Planned Preventive Maintenance
- Form2: General Guidelines for Planned Preventive Maintenance Checklist
- Form3: General Guidelines Maintenance Checklist for Staff/ Users
- Form4: Annual Maintenance Operation Plan
- Form5: Asset Registration Form

6.3.2 Medical Equipment Malfunction Reporting System

Information on equipment breakdown will essentially be obtained from 3 sources-

i. Clinical and administrative night reports
ii. Direct communication from the user to the maintenance unit
iii. Discovery during routine PPM

In any case, equipment breakdown will be treated as an emergency. It is for this reason there will be a technician on call every day including weekends and holidays.

Hospital HCTS coordinator (or a representative) will participate in the daily clinical meetings, during which any breakdown which occurred overnight is reported. The responsible technician will attend to this emergency immediately after the meeting.

Special reporting forms for faulty infrastructure or equipment should be prepared. In case of equipment breakdown, faulty water supply, electricity and the like, the form will be filled out by the person in charge of the function area. The in-charge will immediately call the maintenance unit and report about the fault. The technician will judge the kind of fault and repairs needed and if possible, the duration that the repair works will take.

At this step, the technician will carry out an investigation to identify the cause of the fault/breakdown and draw up interventions to prevent similar causes. Thereafter the technician will take necessary steps to repair the reported fault (see repair management protocol below).

Each equipment in the inventory should indicate whether it is:

- Maintained by in-house technicians
- Maintained by external agency or manufacturer (outsourced)

If there is an equipment breakdown and the hospital maintenance team is not able to diagnose the cause of malfunction or is not able to repair the fault, they will communicate with the regional workshop for assistance. Protocol for managing breakdowns is summarized below in figure 5 and figure 6.

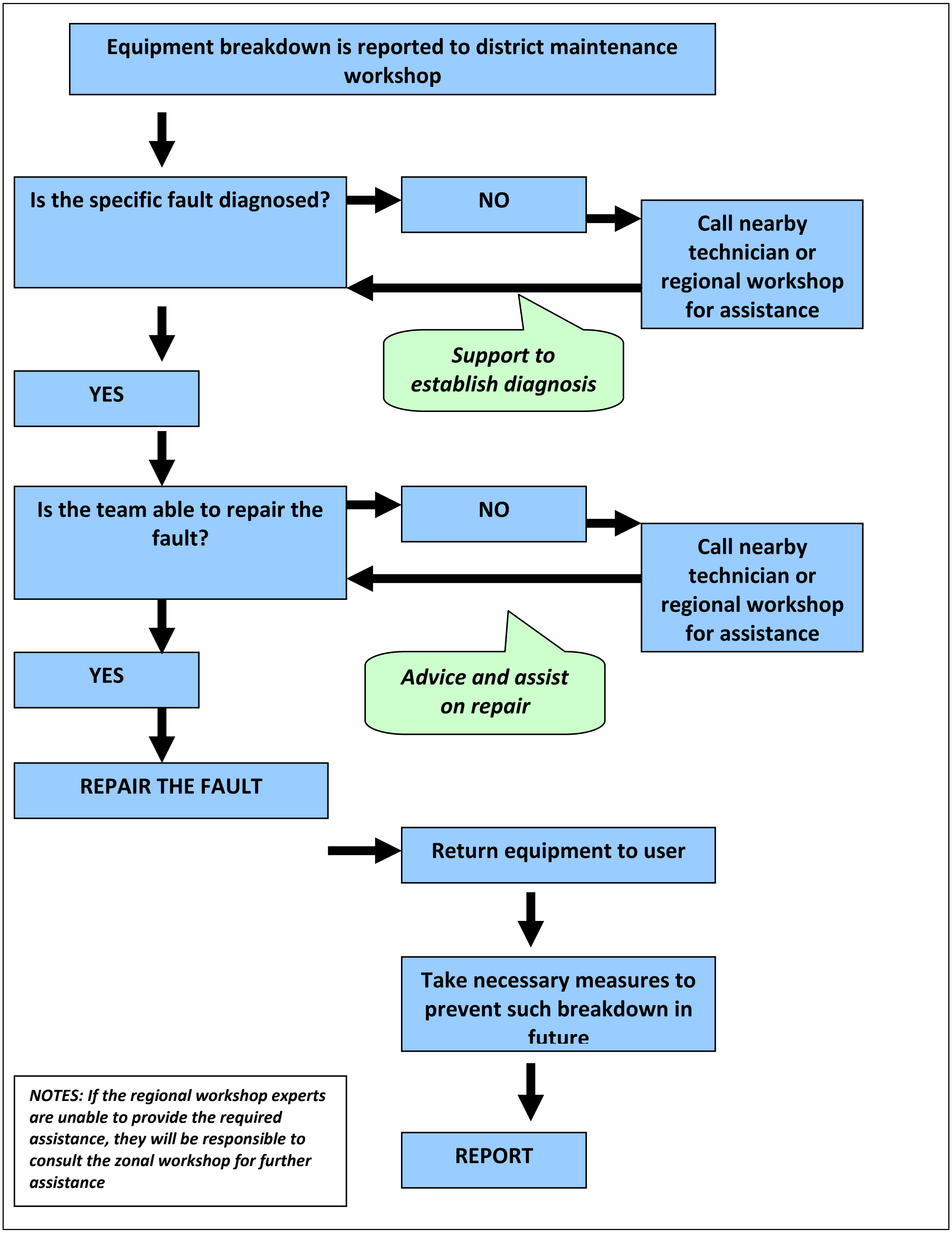


Figure 5: Workshop response to equipment breakdown in a district hospital

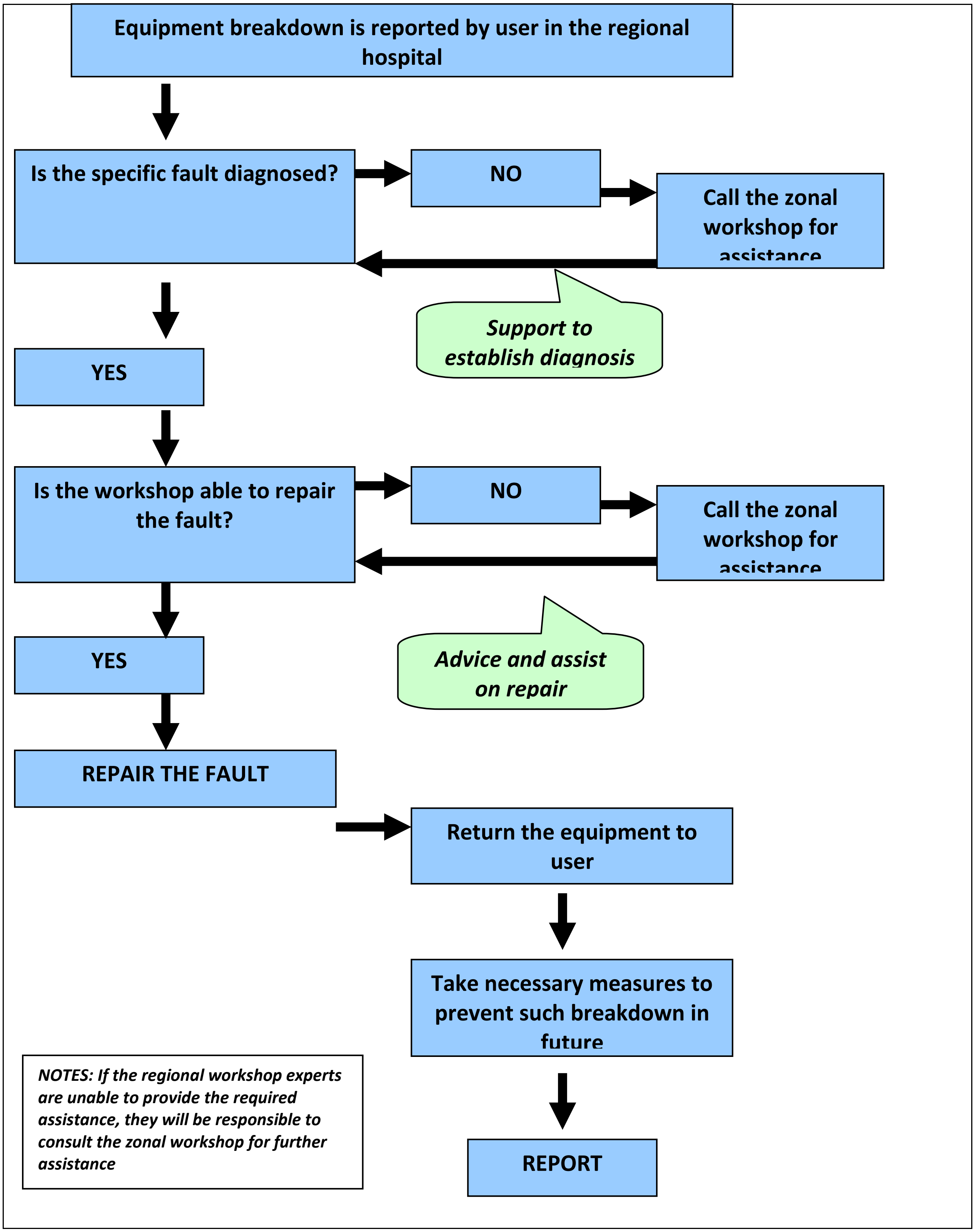


Figure 6: Workshop response to equipment breakdown in the regional referral hospital

6.3.3 Consulting Services for in-house corrective maintenance

Communication is one of the most important aspects for improvement of maintenance at all levels of healthcare services. It is likely that a hospital HCTS team will face challenges to repair defective equipment that falls under the in-house maintenance category. In such cases, the hospital technician will consult peer technicians in nearby hospitals or the regional workshop to identify possibilities for support from these sources.

If this support is available from colleagues, the hospital will pay for the costs to bring the technician and spares as indicated. This situation will be referred to as **consulting services for in-house corrective maintenance**.

Consulting services are intended to further consolidate networking of maintenance and exhaust local potentials before more expensive external potentials are employed.

When it not possible to get support from within the region, the team will request support from the zonal services. Communication should be directly between the team and the zone in order to reduce bureaucracy.

6.3.4 Establish quality control to maintain the quality of service

To maintain the quality of maintenance service, the Biomedical engineering department should establish a quality control system and identify how often maintenance activities should be performed. A formal report with any deficiencies that may have been identified will be submitted to hospital management. The departments will then work with relevant teams to correct any deficiencies.

6.3.5 Maintenance Costing model

The total cost of ownership of medical equipment includes many "hidden" costs of which health systems typically do not consider. That is why it is very important to plan and budget for medical equipment. The most commonly method used for estimating cost of maintenance is Cost of Service Ratio (COSR).

CoSR – annual cost of maintaining assets expressed as a percentage of its purchasing price

$$\text{CoSR} = \frac{\text{Annual Cost of Maintenance}}{\text{Original Purchasing Price}} X\ 100\%$$

The total annual maintenance cost includes cost of mean time to repair (MTTR), spare parts and consumables and maintenance contract.

The estimation CoSR for Tanzania should be as follows:

- For Equipment maintained by outsourced or authorized deals, CoSR should be 5% - 6%

- For Equipment maintained by in house biomedical engineering department, CoSR should be 4% - 5%

6.3.6 Stocking of spare parts and consumables to combat breakdown

Regular and timely availability of spares and consumables is one of the mainstays of quality improvement in health care. Equipment down time is reduced and continuity of care is improved when spares and consumables are readily available. This will not only positively motivate the maintenance team but as well promote satisfaction of health care providers and other clients.

6.3.7 Budgeting for spares and consumables for PPM and Corrective Maintenance

To be able to plan and budget effectively for spares and consumables, a course of action for each piece of equipment in the respective hospital must be carefully and accurately done. The results of this analysis should give a fairly accurate list of types and quantities of spare-parts and consumables for any specific period. The results of this exercise will be used as evidence to budget requirements for maintenance and repair of equipment every year. The estimates (with the justification) will be presented to the hospital management for discussions and approval. Moreover, a mechanism to support emergency requirements (unforeseen in the budget) should also be available.

Additional funds will be required for establishment of buffer stock of spares and consumables as described below.

6.3.8 Regional Buffer Spares and Consumables

Effective maintenance and repair of equipment requires prompt availability of spares and supplies. When spares and supplies required to emergently repair of a broken machine or piece of equipment are readily available, the equipment down time is greatly reduced. However, autonomous management of buffer spares for in-house biomedical engineering department for each hospital is not cost effective. For this reason, the regional referral workshop should also provide services for management of an optimum buffer stock of essential spares and supplies.

Therefore, a sustainable system to source seed funding for stocking essential spares and supplies and a mechanism for paying back with storage and handling charges should be developed.

7.0 Human Resource

Facility should design a mechanism for obtaining required personnel for operationalization of the plant. Maintaining the available staff and also having MoU with other facilities to ensure sustainable availability of the needed personnel will also be required.

8.0 CLINICAL USE OF OXYGEN

8.1 Clinical use of oxygen

Supplies needed:

a. Pulse Oximeter
b. Flow meter
c. Cylinders
d. Nasal Cannula and prong
e. Mask: non-rebreather and face (Adult and paediatric)
f. Concentrator with its package i.e., humidifying bottles, power cable, bacteria and dust filter, common spare parts, backup electricity
g. Oxygen piping and manifold
h. Vital signs monitor
i. Cylinder Valve key/Flow meter spanner
j. Cylinder cart

8.2 Human resource

a. More human resources are needed, including biomedical engineers, clinicians, nurses, and other cadres. This may be in the form of permanent or contract employment

8.3 Health worker training, mentoring, supervision

a. Orientation to biomedical engineers on the newly installed oxygen plants and its equipment
b. User training among HCWs including trouble shooting
c. Training on proper management/administering of oxygen to patients
d. Supervision of Oxygen supply chain (HCWs, equipment and the whole system of supply from generation point to the usage i.e., client) both by National teams, Regional and Councils according to levels

8.4 Guidelines and SOPs

a. Dissemination of Guidelines and SOPs available for Oxygen use to the level of end users i.e. HCWs at the facilities

8.5 Financial Resources

Availability of Financial resources is key towards clinical use of oxygen

a. Funds for procurement of oxygen supplies and consumables
b. Funds for PPM

8.6 Associated emergency and critical care

Patients requiring oxygen are critically ill and require the other elements of emergency and critical care. The first-line care is termed Essential Emergency and Critical Care. All the requirements for Essential Emergency and Critical Care should be present in all health facilities, staff should be trained and there should be national guidelines about its provision.

9.0 COORDINATION

9.1 Coordination Components

The coordination process of scaling-up medical oxygen involves ensuring attainment of six (6) components which focuses on *availability, demand, transport, supply, quality, maintenance and use*. Specifically, the coordination will be provided as follows:

1. ***Availability*****:** Under this component, coordination will involve evaluating and making decisions on production and storage (*cylinders, big oxygen tanks and liquid oxygen tanks*);
2. ***Demand*****:** This will involve receiving and exploring both current consumption and future requirements. This will be primarily determined by the level of health facility or existing situation.
3. ***Transport and Supply:*** This component will examine the logistical processes and transportation requirements, including safety, from generation plant to consumption point.
4. ***Quality Control:*** This involves adherence to the quality standards for medical oxygen respective to the features outlined by WHO and TMDA. Quality control will be at the facility level and applied to the private producers.
5. ***Maintenance:*** This will involve undertaking needs assessments, understanding of technology, compatibility and application of biomedical equipment inventory and testing gears at all levels.
6. ***Use:*** Ensuring oxygen is provided in a safe and effective way to the correct patients, and that patients requiring oxygen receive the other essential emergency and critical care that they require.

9.2 Efficient on Coordination

(i) *The Coordination instrument will consist of a dashboard, checklist, and observation forms* to provide data and information on a daily basis for all five components.

(ii) Moreover, the institutionalization of the coordination depends on the roles and responsibilities articulated in respective instrument. *Proposed mandate (authority, board, executive agency, and regulator) will consist of technical personnel* from all levels.

10.0 MONITORING AND EVALUATION PLAN

The monitoring and evaluation shall among others include indicators reflecting the roles of each entity in the whole cascade as highlighted below.

Table 8: Performance Monitoring of Medical Oxygen Supply

Indicators	Verification	Expected results	Risks
Performance assessment results of increasing access, availability, and reliability of medical oxygen supply from low level to high level healthcare facilities	Semi-annual comprehensive healthcare facilities performance assessment reports	The staff and general population become increasingly satisfied with health services and oxygen therapy provided at healthcare facilities countrywide	Overall hospital performance is influenced by many other functions which may have impacts on the provision of oxygen therapy
Implementation Progress Report for a National Medical Oxygen Supply Scaling-up Plan show a systematic implementation progress	Semi-annual Medical Oxygen Supply Implementation Progress Report	A defined roadmap for medical oxygen scaling up with strategic planning and resource mobilization is in place	Harmonized approach for coordinating the implementation should be in place prior to commencement of implementation
Specific indicators for maintenance in the healthcare facilities performance assessment tool show progressive improvement	Semi-annual comprehensive hospital performance assessment reports at each facility	All healthcare facilities countrywide have sustainable well maintained medical oxygen supply systems, infrastructure, and essential monitoring devices in working order	Improvement in this area is a function of many other factors that need to work together to bring about tangible changes
RHMT and CHMT supervision checklist has elements of HCTS	Supervision reports	HCTS Coordinators are employed, and MEM is integrated into the routine supervision functions of the RHMT and CHMT	On the job training is a crucial element of a functional HCTS system. Supervision should be done by a qualified person as a matter of rule
A qualified maintenance technician/engineer and at least one support staff	HMT manning reports	All healthcare facilities have a fully functional in-house maintenance unit with	Competition for these cadres in the labour market is high. HMT will need to design

		the necessary staff and working tools to undertake in-house maintenance services	and introduce retention schemes
Staff and patients report satisfaction to maintenance status existing systems and infrastructure and essential amenities	Periodic Staff and patient surveys	Existing medical oxygen supply systems and infrastructure are well maintained	Critical changes may not take place especially in budgeting and attitude of staff
Proportion of outsourced maintenance services according to the suggested packages and the infrastructure	Semi-annual and annual Hospital HCTS reports	Maintenance services outsourcing is inherently part of HCTS system of the region	Health care leadership may be slow to accept changes
Budget for maintenance is at least 20% of the hospital annual budget excluding salaries	Hospital plans, budgets, and reports	A realistic budget is allocated and utilized to operationalize HCTS	Hospital management teams do not give maintenance the necessary priority
Proportion of tracer spares and consumables that are available in the buffer stock at any one time	Buffer stock ledgers	A regional buffer stock system is established and operational	Hospitals will not join this system, or they may delay payment of their dues
RHMT, CHMT, HMT and hospital HCTS hold and document regular meetings according to schedule	Minutes of the meeting	Established structures to oversee maintenance improvement in the region are rendering the requisite support	
Selected tracer equipment down time progressively diminishing	Semi-annual Equipment Auditing Report and Performance assessment reports	Equipment down time is progressively decreasing at a healthcare facility	Some of the outsourced maintenance services are not within the control of the hospital or the region

10.1 MoH

a) Coordination of the stakeholders' engagement for oxygen scale up
b) Monitor number of oxygen plan operational staff employed
c) Monitor procurement process and planed activities
d) Exiting of oxygen scale up framework
e) (Determining/Supervising) Roles and responsibilities of committees for the implementation of oxygen
f) Monitor pperformance of committee and scale up process
g) Monitor audit visits

10.2 PORALG

a) Implementation of oxygen scale up framework
b) Monitor number of oxygen plan operational staff employed
c) Ensure iidentified committees are functional
d) Performance of committee and scale up monitoring
e) Monitor audit visits
f) Monitor procurement process and planed activities
g) Monitoring quality of oxygen from the manufacture point to the user

10.3 R/CHMTs

a) Supervision, mentorship during oxygen scale up interventions
b) Monitoring quality of quality of oxygen from the manufacture point to the user
c) Implementation of oxygen scale up framework
d) Monitor number of oxygen plan operational staff employed
e) Monitor regional/council engagement on oxygen plants installation and operations

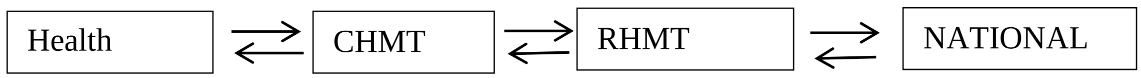
10.4 Facility level/HMTs

a) Monitor routine functionality of installed oxygen plants and its accessories
b) Monitoring the cash flow relating to oxygen plant i.e. oxygen produced vs use vs sales
c) Monitoring capacity building for both health care worker and plant operators.
d) Monitor number of oxygen plan operational staff hired
e) Monitoring adherence to the ooxygen therapy guidelines and SOPs
f) Engagement of managerial teams (Hospital Management Teams)
g) Monitoring oxygen plant maintenance plan and its accessory
h) Monitoring timely response in case of equipment breakdown

Note: Monitoring of available oxygen Plants and new installed plants should regularly be done to determine the Plant production rate, Utilization (production, Quality and Quantity, Usage of product), Maintenance, Capacity of Staff on utilization of plant and its product, Human Resource (1 BME, 2-4 Technicians and Accountants) and Quality of the End Product.

11.0 DATA FLOW

a) Monitor the existing data collection system using the Medical Equipment and Infrastructure Management Information System (MEIMIS).
b) Monitor communication of operationalization oxygen plants among RRH/Specialized/Zonal, RHMTs and Ministerial Level



11.1 Impact assessment

Impact assessment must be done 3 – 5 years after Oxygen Plant Installation. It must address the health and social-economic impact of oxygen gas accessibility.

11.2 Implementation Research

It must be done to evaluate the oxygen plant operations and scale-up at all levels. This process should involve academic institutions, such as universities and research institutions. This also should provide lessons learned from Oxygen plant scale up to identify areas in need of improvement.

12.0 ANNEXES:

ANNEX1: Specifications of Medical Oxygen Systems Equipment and Accessories

Features and Specifications

1. **Oxygen Cylinder**
   - Suitable for use with medical oxygen
   - Oxygen capacity (J) 6800
   - Valve type Bullnose: BS341 No.3 or equipment
   - Outside diameter: 219 mm
   - Water capacity: 50Lt.
   - Test pressure: 250 Bar
   - Nominal pressure: 137 – 150 Bar
   - Cylinders should be made of expanding materials i.e., thin-walled seamless molybdenum steel, aluminum alloy, carbon fiber, or other composite body
   - The cylinder should be designed with protection for risk of an explosion if the cylinder is exposed to intense heat.
   - Meet regulatory requirements and performance standards namely: ISO 9001, CE under TPED and ISO 9809-1

2. **Medical Therapy set**
   - British Standard used with oxygen cylinder
   - Pressure regulator inlet connection is compatible with bullnose valves (BS341 No 3 or equivalent
   - The flowmeter with humidifier is used in adjusting flow rate and adding water vapor to dry gas, which is delivered to patient
   - Oxygen Masks for Adult, Pediatric and Neonatal (venture mask, nasal cannula, face mask)
   - Meet regulatory requirements and performance standards namely: SRA approval and ISO 13485 (medical device QMS).

   Features and Specification
   - Medical Oxygen cylinder regulator with flowmeter and humidifier fitted with safety valve. Once the flow rate has been set, the flowmeter will automatically maintain a constant flow rate irrespective of changing volume of cylinder contents.
   - A pressure gauge indicates the cylinder pressure within range of –200 bar.
   - Oxygen Cylinder Regulator with Flowmeter and Humidifier
Pressure regulator: Inlet pressure 137-200bar, outlet pressure; 3.5bar
Flowmeter: Max gauge inlet pressure 6.9bar, 100psi, 0 – 15 LPM.
Humidifier: 0 – 15 LPM

- Humidifier bottle capacity: 150 – 500cc, Polycarbonate, unbreakable, reusable, autoclavable (134°C)

3. **Automatic Oxygen Manifold Unit**

Manifolds should be connected to the pipeline via a control panel, which provides two equal banks of gas cylinders. The changeover from the “duty” to the “standby” bank of cylinders should be automatic. All manifolds should be capable of passing the full pipeline flow. The temperature of the gas may fall as low as –30°C as the gas passes through the regulator at maximum capacity, and the equipment should be designed accordingly

Features and Specifications

- Medical Gas Manifold (specify the size), Type Automatic type Oxygen Gas Type

Include:

  - High-pressure bank headers, each with:
    - a high-pressure regulator, sensor and gauge
    - primary pressure relief valve
    - a wall mounting bracket
  - Solenoid valve-operated bank change-over
  - Alarm (audible and visual) , providing alarm switch signal or analog signal (for central monitoring)
  - Pipeline, pigtails and middle frame
    - Size of the connecting hose is customized
    - non-return valve
  - Secondary relief valve assembly comprising line pressure release valve and exhaust line
  - Line pressure sensor, and line regulator fitted with safety valves
  - Supply line isolation valve (lockable)
  - Test point (medical gas terminal unit)
- Closed metal box, an interference
- Pass the pressurization hydraulic testing at 400 bar, welded in silver, safety and stable
- Adopt pilot differential pressure control, accurate pressure control, and low failure rate
- With temperature control to prevent frost and overheating leakage
- The pipeline adopts loose joint, which makes maintenance more convenient
- Power Supply: 110VAC to 240 VAC, 50Hz
- Max. Flow: 100m3/h
- Application: O2, etc.
- Max. Pressure: 23Mpa 0.4 ~ 1.0Mpa (adjustable)
- Safety Valve opening pressure: 1.25Mpa

4. **PSA Oxygen Plant Features and Specifications**

Plant Type: PSA Oxygen Generator with 200lts Filling Station

System Description:

- Oil free Compressor with Integrated Refrigerated Air Dryer
- Air Receiver 1000lts with Pressure Relief Valve Assembly and Electronic Tank Drain
- Filtration package
- Oxygen Receiver 1000lts with Oxygen Line Regulator, Pressure Relief Valve Assembly, Bacteria Filter and Auto Shutdown Solenoid Valve
- Oxygen PSA generator (specify capacity in Nm^3/hr)
- Interconnecting Piping & Electrical with Main Electrical Breaker Panel
- Oxygen Booster Compressor
- 2 x (specify) Valve High Pressure Oxygen Cylinder Filling Manifold with 20 BSP and 2 pin index Pigtails and Steel Cylinder Rack with Safety Chains
- 2 x Cylinder Evacuation Vacuum Pump w/ 4 Valves & BSP Adaptors
- 2 x Digital Flow Meter Assembly.
- Dedicated power generator and power protection (e.g., voltage stabilizers and surge suppressors)
- Duplex configuration option strongly favored.

This plant will be manufactured and tested to the climatic conditions of the Tanzania at altitude of designated site (specify) above sea level.

System Specifications

PSA Oxygen Generator

- With Touch Screen Control Panel with Integrated Oxygen Monitor, Audible Low Purity Alarm. Includes Air Filtration Package consisting of Particulate Pre-Filter (>5 micron), Coalescing Filter 0.01 micron and Carbon Adsorption Filter (coal tower, if applicable)
- Product flow rate (Total): specify
- Product O2 delivery pressure: < 4 - 6 bar
- Product Purity : USP 93%±3%
- Cylinder filling capacity: < 200 per 24hrs.
- Oxygen Receiver characteristics: Total capacity < 2000lts, with Oxygen Line Regulator, Pressure Relief Valve Assembly, Bacteria Filter and Auto Shutdown Solenoid Valve
- Average Power Consumption: 2.2 kWh (±5%) per Nm3 of product O2

Air Compressor Specifications.

- Air Compressor included for elevation: (specify)
- Ready-to-run, fully automatic, super silenced vibration damped, all panels powder coated. Suitable for use in ambient temperatures up to +45°C
- User Interface: Touch screen, PC architecture, offers the capable of Dual, Quadro , Vario and continuous control.

- User interface automatically controls and monitors the compressor package. The interface enables exchange of data and operational parameters allowing the control to communicate with other air management systems
- Interfaces should be provided as standard for connection of modem or printer, a second compressor in base-load sequencing mode and for connection to data networks
- Rotary screw compressor or equivalent.
- Integrated refrigerated air dryer
- Minimum working pressure: 7.5 bar
- Power: 3 phase, 380v/ 50Hz
- Sound level: 65-70 dB, Sound insulated
- Cooling: Fluid and air flow cooling.
- In built oil separation system.
- Total Air receiver capacity: < 1000 lts, with pressure relief valve and electronic tank drain

Oxygen Cylinder Filling Compressor (Booster) Specifications

- Maximum discharge Pressure: <2200 PSIG
- Cooling: Air
- Number of stages: 3
- Lubrication Type: Oil Free
- Safety Control: High Pressure safety shut down.

Electrical Power Specifications

- PSA Unit: Approximately 2 x 0.6 kW (220V / 50 Hz / 1 phase)
- Feed air Compressor: Approximately 2 x 25 kW (380V / 50 Hz /1 phase)
- Feed air refrigerated dryer: Included with Air Compressor
- Oxygen Compressor : Approximately 2 x 7.5 kW (380V / 50 Hz / 3 phase)

Certification and Standards of Construction

- ISO 9001:2008, ISO 13485, ISO 14001:2004
- STANDARDS: NEMC, ASTM International, ASME
- CE APPROVED under MDR

System Features

- Complete turnkey system, with automatic stop/start. Energy efficient process design.
- Reliable, accurate, continuous online oxygen purity monitor with alarm. Auto system shutdown if the monitored oxygen purity falls below preset limits.
- Easy to operate and maintain. With proper maintenance, unit should provide over 10-15 years of service.
- Warranty against defect in materials and workmanship for a period of two years after commissioning or 26 months after shipment, whichever is first.

- 2 year consumable spare parts for PSA system, Air Compressor and oxygen cylinder filling compressor included in the offer.
- Additional necessary emergency spare parts should be included

Requirements, Delivery and Installation:

- 24/7 Local presence
- Shortest delivery period desirable.
- Installation cost included in offer.
- Training offered for 2 engineers to ensure transfer of technology and also future maintenance.
- 2 weeks minimum full factory level training
- Training scope: Assembly, repair, maintenance and service of the Oxygen generator and Compressors.

ALL BROCHURES, USER AND SERVICE MANUALS DETAILING PROTOCOLS FOR OPERATIONS, CLEANING AND MAINTENANCE PROCEDURES, TROUBLESHOOTING PROTOCOLS AND SPECIFICATIONS SHOULD BE PROVIDED

5. Liquefied Medical Oxygen Tank (LOX) Features and Specifications

- Duplex configuration
- Designed to store liquefied medical oxygen at low evaporation rate
- Should be designed with cryogenic storage tank, ambient vaporizers, and a pressure control system automatic pressure regulator and liquid level display
- Should be a double walled vacuum insulated vessel
  The inner wall should be made of stainless steel designed for a positive pressure at cryogenic temperature, with a vacuum between them (Filled with perlite under vacuum), to insulate the contents from ambient heat
- Maximum Allowable Working Pressure of 16 to 18 Kg/cm^2 or based on supplier and gross volume of tank
- Certification: certified standards as per ASME/EN/Equivalent
- Recommended Storage capacity: (specify)
- Should be supplied with interconnecting pipe between tank and vaporizer. Foundation bolts for tank and vaporizer.
    - Vaporizer sized to meet 100% of peak demand (specify)
- Installation requirements: Allocated open space should be at least 5x5m space, 8m from facility or other safety hazards, per HTM at ground level and should be accessible for smooth movement of LMO tanker to/from the site.
- Quantity: 10 KL x 1 No.
- Installation: Outdoor

- Type: Double walled, vertical
- Capacity: Minimum 20,000 liters water capacity
- Max. Working pressure: 17 Bar G
- Design temperature: -196 to +50 degrees Centigrade
- Hydraulic Test Pressure: 26 bar G
- Type of Insulation: Vacuum, perlite filled Safety Valve Set pressure valve: 17 Bar G (Dual safety valve with three way diverter valve)
- Bursting Disc Set Pressure: 23 Bar G
- Standard fittings: Pressure rising coils capacity and size, dual safety valve with imported three way diverter valve, bursting disc., pressure gauges, liquid over flow line, liquid level gauge and adequate numbers of extended spindle glove valve etc.
- The pressure regulator installed should be made of suitable material (Nonferrous) with bonnet & trim parts. Inlet pressure max. 20 Kg/sq cm. outlet pressure range within 0.5 to 10 kg per sq. cm (adjustable).
- Maximum Evaporation Rate :<1% of net value

Material of Construction:

- Inner shell and wetted parts of SS 304
- Outer shell of CS ASTMA 516 Gr. 70 / CGA 341 2002 EN13455 S275/S355
- Joint Efficiency: 100%
- Radiography: 100% for inner, for outer spot
- External piping: From LOX Tank to Vaporizer SS304.
- From Vaporizer to inlet of Pressure Reducing Station SS304.
- From Outlet of Pressure Reducing Station to Main header Copper.
- Cryogenic Valves: Non-ferrous
- Cryogenic Safety Valves: Non-ferrous
- Pressure Building regulator: Non-ferrous with standard specifications.
- Leak Detection test: Helium Leak detection
- Inspection: Authorized Inspection Authority
- Cleaning Nitrogen: with degreasing for Service and Pressurize
- Withdrawal rate: 1000 cum per hr. at 12 bar G

Should have safety features in line with Global Safety as part of installation the minimum safety (alarm) features for LOX installation are as follows:

- Alarm VIE (Vacuum Insulated Evaporator) for low content level (audio-visual) and low pressure alarm (audio-visual) and backup at manifold room.
- Alarm VIE low pressure alarm (audio-visual) low pressure in pipeline system for deviation or fall in pipeline pressure by more than ± 10% from nominal distribution pressure (The nominal distribution pressure should be within the range of 400kPa to 500 kPa).

- Alarm for changeover from primary to secondary supplies.
- Alarm for secondary or reserve supply below minimum pressure.
- Dual parallel regulator system for uninterrupted supply in case regulator has to change for repair. One regulator is set at 4.2 bar and the other at 3.8 bar as per international practice.
- Three-way gauge valve for isolation of line pressure with manual maneuver.
- Remote monitoring telemetry-continuous monitoring of VIE stock based on daily consumption (automatic modification of tank replenishment).

Pressure Reducing Station

- The healthcare facility supply pipeline reducing station which reduces supply pressure must consist of a dual parallel regulator system.
- Both regulators must be online, and all isolation valves and regulators must be kept in the open position.
- The nominal distribution pressure should be maintained within the range of 400kPa to 500kPa.
- Pressure relief valve – Medical oxygen pipeline system should be provided with a pressure relief device downstream of the line pressure regulator connected by means of a 3-way valve.
- Material used should conform to lubricants
- The control equipment should be protected from weather.

6. **Medical gas Alarm system:**

- Three gas alarm including oxygen
- Individual gas status LED indicator-showing NORMAL, HIGH and LOW conditions for each service
- Audio alarm for high and low pressure condition
- Display of line ppressure for all the services with factory calibrated pressure sensors.
- Alarm test / check / mute needed
- Small and compact in design
- Mounted on a powder coated MS box
- Nut and nnipples are to be provided for connection with pneumatic supply line
- Low voltage internal operation with input power supply of 220VAC
- Battery bbackup
- Easy wall mounting facility.
- The model should be IEC 60601-1-2 compliant
- It should be compliant to ISO7396-1/NFPA 99/HTM standards.
- The product should be CE Certified or by any other International recognized Authority.

7. **Medical Gas Pipeline System (MGPS)**

Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves which have been greased, cleaned for medical oxygen service, and fittings brought in polythene sealed bags shall be used at site. Pipe fixing clamps shall be of non-ferrous or non-deteriorating plastic suitable for the diameter of the pipe.

- All joints shall be made of copper and brazed by silver brazing filler material without use of any flux.
- All brazing shall be done by using a brazing rod CP 104 (5% silver-copper phosphorous brazing alloy) and copper-to-brass or gunmetal shall only be joints using brazing rod AG 203 (43% Silver-copper-zinc-brazing alloy) manufactured to EN-1044.
- Inert gas welding technique should be used by oxygen free Nitrogen gas inside copper pipes while brazing to avoid carbon deposition.
- Copper pipe's thickness and size: will depend on system design
- Adequate supports shall be provided while laying pipelines to ensure that the pipes do not sag.
- Suitable sleeves shall be provided wherever pipes cross through walls / slabs.
- All pipe clamps shall be non-reactive to copper.
- After erection, the pipes will be flushed and then pressure tested with dry air or nitrogen at a pressure of 480kPa [20% greater than operation pressure] for a period of not less than 24 hours.
- The entire piping system shall be tested in the presence of the site-engineer or his authorized representative.
- All exposed pipes should be painted with two coats of synthetic enamel paint and color codification should be as per ISO: 2379 of 1963

8. **Mobile Oxygen Concentrator (Dual or Single) Oxygen Outlet**

Features

- Should be PSA technology and easy to move around
- Should be capable of producing oxygen of purity 90% to 96%
- Should be able to work efficiently at an altitude 0m to 5000m above sea level, operating temperature 5°C to 45°C
- Should be designed with double to triple dust protection
- Complete unit to be easily washable and sserializable using both alcohol and chlorine solution

Specifications

- Flow rate: 0 – 10lpm, purity > 93% ± 3%
- Unit capable of supplying oxygen to two outlets (dual outlets) simultaneously using two independent flow meters (option)
- Oxygen delivery pressure: 0.03 to 0.07 MPA (0.3 – 0.7bar)
- Atomizing pellet (ml/min) > 0.5, uninterrupted flow of oxygen
- Inbuilt oxygen purity monitoring system
- Low oxygen alarm, high pressure alarm and power failure alarm
- Settings: should be capable of providing minimum 12 hours of continuous operation
- User's interface: Front digital panel access to reset switch
- Power supply: 230 ± 20% V ac, 50 Hz

Accessories, Spare parts, and Consumables

- Humidifier Bottles, 4pcs
- Power cord – 1pc
- Set of nasal prongs and face masks for adult, pediatric and neonates with extension tubing – 4pcs
- Gross cabinet filter, compressor intake filter and bacterial filter of 0.8 – 1.0 micron; zeolite crystal – 4 pcs

Standards and Safety

- CE under MDR or FDA approved and company should be ISO 13485 certified; and shall meet IEC 60601-1 standard requirements and be complete with ISO 15001
- Warranty period: 2 years from date of operation
- Should be supplied with operation and maintenance manuals

ANNEX2:

List of working tools and Test Equipment for In-house Maintenance Workshop

Pos.	Description	QTY	Price TZS	Total
1	SILVER-TOOLBOX (465X170X310 MM)	2	345,600.00	691,200.00
2	Multimeter 87V HAND - MULTIMETER Digital incl. Temperature sensors, test prod, crocodile clips, manual, reference guide	1	1,221,600.00	1,221,600.00
3	Oxygen Analyser Meter • Portable analyzer should be super	1	1,500,000.00	1,500,000.00

	accurate and easy to use • Ultrasonic oxygen sensor with accuracy ≤±2% • Should have option for calibration • Large digital screen with battery status • The Oxygen Analyzer is specially used for detecting the concentration of O2 generated by molecular sieve O2 Concentrator **Specification:** • Accuracy: +/-2% F.S. • Max. Flow: 15Lpm • Low battery voltage reminding • Operating Ambient Humidity :< 95% • Concentration Indication Range: 21% - 100% • Sensor type: Ultrasonic Oxygen Sensor • Display: Display % oxygen purity and pressure with resolution of 01% • Max. Pressure: 60PSI • Response Time: 10S • Working battery time: 24 hours • Power Source: DC 3.7V Li-ion battery (Re-chargeable) • At least 1 year manufacturer warranty			
4	Heavy Duty Ladder, long (8 steps)	1	858,000.00	858,000.00
5	Heavy Duty Ladder, short (3 steps)	1	411,840.00	411,840.00
6	Soldering iron	1	86,280.00	86,280.00
7	De-soldering Tool	1	29,280.00	29,280.00
8	Torch	1	46,080.00	46,080.00
9	Testprod Set, clip, red	3	11,760.00	35,280.00
10	SCREWDRIVER SET 32-PARTS IN STEEL CASE	1	136,080.00	136,080.00
11	HAMMER DIN 1041, 300 g.	1	24,360.00	24,360.00
12	Ball Head TORX ANGLED Set, 8-parts	1	79,080.00	79,080.00
13	Mirror, 225 mm	1	47,880.00	47,880.00

14	Knife, 165 mm Interlock	1	20,760.00	20,760.00
15	Folding magnifier, 6-fold, d=23MM	1	77,400.00	77,400.00
16	Wire stripper No. 40	1	71,880.00	71,880.00
17	WATER PUMP PLIERS, 250MM, 7X adjustable joint	1	34,560.00	34,560.00
18	SCISSORS STAINLESS STEEL, 190MM with ergonomic handle	1	22,200.00	22,200.00
19	SIDE CUTTER VDE ISO 5749, 160mm, chrome plated	1	47,880.00	47,880.00
20	UNIVERSAL PLIERS, 160mm, chrome plated	1	54,120.00	54,120.00
21	CHAIN NOSE SIDE CUTTING PLIER 160 MM, chrome plated	1	48,600.00	48,600.00
22	CHAIN NOSE SIDE CUTTING PLIER, 160mm, chrome plated	1	43,200.00	43,200.00
23	ELEKTRONIC - SIDE CUTTER 112 MM	1	41,640.00	41,640.00
24	ELECTRONIC - ROUND PLIER 125 MM, spitz round	1	32,880.00	32,880.00
25	SELF LOCKING TWEEZERS, 160mm, nickel plated	1	33,360.00	33,360.00
26	SELF LOCKING TWEEZERS, nickel plated 160mm	1	33,360.00	33,360.00
27	COMBINATION WRENCH SHORT VERSION, 19mm	1	16,800.00	16,800.00
28	COMBINATION WRENCH SHORT VERSION, 18mm	1	17,160.00	17,160.00
29	COMBINATION WRENCH SHORT VERSION, 17mm	1	14,400.00	14,400.00
30	COMBINATION WRENCH SHORT VERSION, 16mm	1	14,880.00	14,880.00
31	COMBINATION WRENCH SHORT VERSION, 13mm	1	12,120.00	12,120.00
32	COMBINATION WRENCH SHORT VERSION, 10mm	1	10,320.00	10,320.00
33	COMBINATION WRENCH SHORT VERSION, 8mm	1	10,080.00	10,080.00
34	COMBINATION WRENCH SHORT VERSION, 7mm	1	9,720.00	9,720.00

35	COMBINATION WRENCH SHORT VERSION, 5.5mm	1	14,640.00	14,640.00	
36	Voltage tester 150-250 Volt	1	14,760.00	14,760.00	
37	Screwdriver size 2	1	20,880.00	20,880.00	
38	Screwdriver size 1	1	15,120.00	15,120.00	
39	Screwdriver size 0	1	11,880.00	11,880.00	
40	Screwdriver 5,5x125 mm	1	15,960.00	15,960.00	
41	Screwdriver 4x100 mm	1	14,400.00	14,400.00	
42	Screwdriver 3,5x100 mm	1	12,120.00	12,120.00	
43	Screwdriver 2,5x80 mm	1	10,200.00	10,200.00	
44	Screwdriver size 01 x25 mm	1	9,360.00	9,360.00	
45	Screwdriver 5,5x25 mm	1	8,160.00	8,160.00	
46	Screwdriver PH 0	1	7,560.00	7,560.00	
47	Screwdriver PH 00	1	9,000.00	9,000.00	
48	Screwdriver 3,0 mm	1	6,720.00	6,720.00	
49	Screwdriver 2,5 mm	1	6,720.00	6,720.00	
50	Screwdriver 2,0 mm	1	6,480.00	6,480.00	
51	Screwdriver 1,8 mm	1	7,560.00	7,560.00	
52	EPA, Field service kit, 8 parts	1	177,000.00	177,000.00	
53	Glass fiber cleaning pen, 115 mm	1	20,760.00	20,760.00	
54	Soft Cleaning Brush	1	3,600.00	3,600.00	
55	Portable Drilling Machine	1	765,600.00	765,600.00	

ANNEX 3

Cost Estimates of Medical Oxygen Devices and Accessories

Assumption

- Oxygen Plant should have capacity to refill 200 cylinders per day
- Primary oxygen supply will be main pipeline from oxygen plant and secondary supply will be manifold unit
- A manifold unit with 20 type J cylinders will supply oxygen gas to 3 departments
- Area Alarm Unit for Monitoring pipeline pressure will be installed to each manifold
- Location from one department to another department is estimated to be 50M apart
- Distance from Oxygen generation plant to manifold is 100M

The supply will be done as summaries in the table below:							
S/N	**Dept.**	**No of beds**	**No of O2 outlets**	**No of Vacuum outlets**	**No of Air Outlets**	**No of N2O outlets**	
1	EMD Dept.						
	Resuscitation	5	5	5	5	5	
	Treatment	5	5	5	5	5	
2	OP Dept.						
	Anaesthesia	2	2	2	2	2	
	Theatre	4	4	4	4	4	
	Recovery	4	4	4	4	4	
3	Maternity Dept.						
	Labor room	4	4	4	4	4	
	Pre-Natal	10	3	3	3	3	
	Post-Natal	10	3	3	3	3	
	Pre-mature	10	10	10	10	10	
4	Renal Dept.	10	5	5	5	5	
5	ICU Dept.	10	10	10	10	10	
6	Paed Ward	10	5	5	5	5	
7	Male Ward	10	5	5	5	5	
8	Female Ward	10	5	5	5	5	
9	Private Ward	10	10	10	10	10	
	Total Outlets		80	80	80	80	
Condition:							
• All terminal units should not be interchangeable							
• Operating pressure more than 6 bar							
• Minimum withstand pressure = 13 bar							

Estimate of the requirements for Installation of Oxygen Plant, refilling capacity of 200 cylinders per day and intra- medical oxygen pipelines						
No	**ITEM**	**DESCRIPTION**	**QTY**	**UoM**	**COST/UNIT ($)**	**COST ($)**
1	PSA Medical Oxygen Generation Plant	As per technical specifications in ANNEX1	1	pc	500,000.00	500,000.00
2	Automated Manifold Unit	As per technical specifications in ANNEX1	3	pc	5,000.00	15,000.00
3	Oxygen Cylinder Type J	As per technical specifications in ANNEX1	100	pc	200.00	20,000.00
4	Medical Gas Pipeline System (MGPS)					
	Copper pipe for medical use with 15 OD X 1.0mm, with Munsen Ring	As per technical specifications in ANNEX1	1000	M	7.00	7,000.00
	Copper pipe for medical use with 22 OD X 1.0mm, with Munsen Ring	As per technical specifications in ANNEX1	1000	M	15.00	15,000.00
	Copper pipe for medical use with 28 OD X 1.00mm, with Munsen Ring	As per technical specifications in ANNEX1	1000	pc	25.00	25,000.00
	Copper pipe for medical use with 35 OD X 1.00mm, with Munsen Ring	As per technical specifications in ANNEX1	3000	pc	40.00	120,000.00
5	Copper Type K Elbow 15mm	Type K, 15mm	3000	pc	1.00	3,000.00

6	Copper Type K Elbow 22mm	Type K, 22mm	3000	pc	1.20	3,600.00
7	Copper Type K Elbow 28mm	Type K, 28mm	3000	pc	1.50	4,500.00
8	Copper Type K Elbow 35mm	Type K, 35mm	500	pc	2.00	1,000.00
9	Copper Type K Straight-line Coupling 15mm	Type K, 15mm	2000	pc	1.00	2,000.00
10	Copper Type K Straight-line Coupling 22mm	Type K, 22mm	2000	pc	1.20	2,400.00
11	Copper Type K Straight-line Coupling 28mm	Type K, 28mm	2000	pc	1.50	3,000.00
	Copper Type K Straight-line Coupling 35mm	Type K, 35mm	2000	pc	2.00	4,000.00
	Copper Type K Reducer	Type K, 22-15mm	100	pc	1.50	150.00
	Copper Type K Reducer	Type K, 28-22mm	100	pc	2.00	200.00
	Copper Type K Reducer	Type K, 35-28mm	10	pc	2.50	25.00
1	Area-Valve-Service-Unit (AVU), Type K, 35mm	As per technical specifications in ANNEX1	9	pc	200.00	1,800.00
	Ball Valve, Type K, 15mm	Type K, 15mm	100	pc	30.00	3,000.00
	Ball Valve, Type K, 22mm	Type K, 22mm	50	pc	35.00	1,750.00
	Ball Valve, Type K, 28mm	Type K, 28mm	10	pc	40.00	400.00
	Medical Therapy	As per technical specifications in	100	Set	200.00	20,000.00

		ANNEX1				
7	BS Standard Gas outlets with housing gas type	As per technical specifications in ANNEX1	100	pc	100.00	10,000.00
8	Male Adapter	Oxygen BS type 1/8 NPT	100	pc	50.00	5,000.00
8	Installation, Testing and Commissioning	As per technical specifications in ANNEX1	1	facilit y	45,000.00	45,000.00
		Total				**812,825.00**

ANNEX4:

Documentation of Maintenance Systems (Form1 to Form 5)

MASTER EQUIPMENT OPERATIONAL CHECKLIST
for PLANNED PREVENTIVE MAINTENACE (PPM)

Name of Regional / District:	
Name of Healthcare Facility:	

				Indicate Period for PPM Activities											
No.	**Equipment Group/Category**	**Equipment Name**	**PPM Freq (mths)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															
11.															
12.															

GENERAL GUIDELINES For
PLANNED PREVENTIVE MAINTENANCE (PPM) CHECKLIST

Name of Regional / District:	
Name of Healthcare Facility:	
Medical Equipment Information	
Name of Equipment:	
Equipment Group/Category:	
Equipment Function / Application:	1)
Brand / Model in Hospital (1):	
Brand / Model in Hospital (2):	
Brand / Model in Hospital (3):	
PPM Interval:	**[ ] 3 months [ ] 6 months [ ] 12 months**

	PPM Check List for Biomedical Engineer / Technician			
No.	**Descriptions**	**PASS**	**FAIL**	**Remarks**
	PHYSICAL INSPECTION			
1.				
2.				
	QUANTITATIVE INSPECTION			
1.				
2.				
	INSPECTION OF ACCESSORIES			
1.				
2.				
	CALIBRATIONS			
1.				
2.				

	PPM Check List for Biomedical Engineer / Technician			
No.	**Descriptions**	**PASS**	**FAIL**	**Remarks**
	ELECTRICAL SAFETY INSPECTIONS			
1.				
2.				
	LIST OF INSTRUMENTS / TOOLS / MATERIALS REQUIRED			
1.				
2.				
	OTHER INFORMATION / OBSERVATIONS / COMMENTS			
1.				
2.				

GENERAL GUIDELINES
MAINTENANCE CHECKLIST FOR STAFF / USER

Name of Regional / District:	
Name of Healthcare Facility:	
Medical Equipment Information	
Name of Equipment:	
Function / Application:	
Brand / Model in Hospital (1):	
Brand / Model in Hospital (2):	
Brand / Model in Hospital (3):	

Troubleshooting Guidelines for simple failures and breakdowns			
No.	**Fault / Problem Detected**	**Possible Causes**	**Solutions**
1)			
2)			
3)			

Staff (User) Maintenance Checklist			
No.	**DAILY ACTIVITIES**		
1)	Cleaning		
2)	Audio-Visual Checks		
3)	Functional Checks		

No.	WEEKLY ACTIVITIES		
1)	Cleaning		
2)	Audio-Visual Checks		
3)	Functional Checks		

ASSET REGISTRATION FORM	
Name of Regional / District:	
Name of Health Care Facility:	

General Information of Equipment:

New Asset Code:	………………………………… …………………..	**Old Asset Code** (if any):	…………… …………… …………….
Description:	…………………………………………………………………… ……………………………………………………..………..		
Manufacturer/ Brand:	………………………………… ………….…………	**Model No.:**	…………………… ………………..…… …………
Country Of Origin:	………………………………… …………………………	**Serial No.:**	…………………… ………………..…… …………
Year Manufactured:		**Year Purchased /Installed:**	…………… ………….. ………..

Description Main / Sub Components	**Brand / Model**	**Serial No.**	**Sub-Codes**

<u>Location</u> Department:	………………………………… ……………..	**Room:**	…………………… ……………….……. …………

Equipment Type: ☐ Medical Equipment ☐ Non-Medical Equipment

General Information of Equipment:

Equipment Category:

- ☐ Critical Care Eqpt (*eg.Anaesthesia/Ventilator*)
- ☐ Laboratory Equipment
- ☐ Imaging Equipment
- ☐ Monitoring Equipment
- ☐ Sterilization Equipment
- ☐ Surgical Instruments
- ☐ OT Equipment
- ☐ Physiotherapy Equipment
- ☐ Medical Furniture (*eg. Beds, trolley, etc*)
- ☐ Loose Furniture (eg. Office, domestic, etc)
- ☐ …………………………………………………………
- ☐ ……………………………………………………………

Type of Procurement:

- ☐ DoH
- ☐ MoH
- ☐ ODA
- ☐ Hospital
- ☐ Donation
- ☐ Profit Sharing/Leasing
- ☐ Others ……………………………………………………………………………

Cost/Value of Asset: …………………….... Estimated yearly maintenance cost: ……………………… Estimated Life Expectancy: ……………………………..

Comments (if any): ……

Name of Supplier: …………………………………………………………… **Address:** ………..

Contact details: Telephone: ………………………………………….. Fax: ……………………………………

General Information of Equipment:

……….

Contact Person(s)
1)………………………………………………………
Position:………………………………….. Mobile:…………
2)………………………………………………………
Position:…………………………………….. Mobile:…………….
3)………………………………………………………
Position:…………………………………….. Mobile:…………….

Warranty Period: Start: ……………………… ………………… End: ……………… ……………… …………

Equipment Status:

☐	New Equipment	☐	Existing Equipment

☐	Good Condition [*Rank: 10 to 7*]	Points: ……………
☐	Fair Condition [*Rank: 7 to 5*]	Points: ……………
☐	Poor Condition [*Rank: 4 to 1*]	Points: ……………
☐	Not working /Cannot be repair / To be decommissioned	

Comments: ………………..…………
……………………………………………………………………
……………………………………
………………..…………………………………………………
…………………………………………………………………

List of Accessories / Sub-Components:

Description of Accessories	Brand / Model / Serial No. (If any)	Part No.	Qty

General Information of Equipment:

Documents provided: ☐ Operating Manual ☐ Service Manual

☐ Drawings / Diagrams ☐ CD/DVD (soft copy)

☐ Others……………………………………………………… …………………………

Maintenance Contract (existing): ☐ Yes ☐ No Period: …………………………… …………………………… ……….

Type / Condition of Contract: ……………………………………………………………… ……………………………………………………..…………..

Name of Service Provider: ……………………… ……………… **Address & Contacts :** ……………………… ……………………… ………… ……………………… ……………………….. ……… ……………………… ……………………… ………..

Contact Person(s)
1)……………………………………………………
Position:…………………………………………..
Mobile:…………….
2)……………………………………………………
Position:…………………………………………..
Mobile:…………….
3)……………………………………………………
Position:…………………………………………..
Mobile:…………….

Recommended PPM frequency: Every ……………….….. month / year

(Please refer to separate records)

General Information of Equipment:

PPM Checklist:	☐ Yes	☐ No	☐ Others………………… …………………….
Spare parts list:	☐ Yes	☐ No	☐ Others………………… …………………….
Consumables list:	☐ Yes	☐ No	☐ Others………………… …………………….
Maintenance service history:	☐ Yes	☐ No	☐ Others………………… …………………….

Comments: ………………………………………………………………… …………………………………..………. ………………………………………………………………… …………………………………..………. ………………………………………………………………… …………………………………..……….

	Recorded By:	**Reviewed / Checked By:**	**Approved By:**
Signature:	....	....	....
Name:	....	....	....
Position:	....	....	....
Date:	....	....	....

13.0 Reference:

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ANNEX.1; COSTED FRAMEWORK.

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
1. MEDICAL OXYGEN SOURCES AND PRODUCTION										
1	OXYGEN PRODUCTION AT DISPENSARY LEVEL	Procurement of 6 type J oxygen cylinders at dispensary level	This is proposed to ensure, 2 cylinders will in use, 2 stored and 2 at the filling site	pc	6	460,000	6,301	17,390,760,000	7,561,200	Key units ti be supplied with oxygen cylinders - OPD, Observation room, labor room, / A minimum of 6 cylinders are required for each Dispensary for both 1687 private and 5409 Government owned facilities
		Procurement of 2 type D oxygen cylinders at dispensary level	The cylinders will be used for inter - and intra facility patient transfer	pc	2	230,000	6,301	2,898,460,000	1,260,200	
		Procurement of 6 wall mounted cylinder racks at dispensary level	Each rack will be used for mounting each cylinder	pc	6	100,000	6,301	3,780,600,000	1,643,739	As per the number of cylinders procured for each facility
		Procurement of 3 oxygen concentrators with a flow of 15LPM maximum flow at dispensary level	3 pieces of concentrators will be used for each facility as a backup in case of shortage	pc	3	4,332,900	6,301	81,904,808,700	35,610,786	
		Procurement and installation of 2 cylinders manifold systems	For a centralized oxygen delivery in a facility	pc	1	11,500,000	6,301	72,461,500,000	31,505,000	
		Procurement of 3 oxygen cylinder flowmeters	The cylinder flowmeters be used, in case the pipe network has any fault	pc	3	325,100	6,301	6,145,365,300	2,671,898	
		TOTAL						**184,581,494,000**	**80,252,823**	**Potential to be costed by the oxygen use group**
	OXYGEN PRODUCTION ATHEALTH CENTER LEVEL	Procurement of 20 type J oxygen cylinders at health center level	10 Cylinders to be in use and 10 cylinders under transport	PC	20	460,000	1,009	9,282,800,000	4,036,000	667 Government owned and 295 private owned facilities
		Procurement of 10 wall mounted cylinder racks at health center level		pc	10	100,000	1,009	1,009,000,000	438,696	
		Procurement of 6 type D oxygen cylinders at health center level	The cylinders will be used for inter - and intra facility patient transfer	pc	2	230,000	1,009	464,140,000	201,800	
		Procurement of 10 oxygen concentrators at health center	The oxygen concentrators will be used for each facility as a backup in case of shortage	pc	10	4,332,900	1,009	43,718,961,000	19,008,244	
		Procurement of 10 oxygen cylinder flowmeters	The cylinder flowmeters be used, in case the pipe network has any fault	pc	10	325,100	1,009	3,280,259,000	1,426,200	
		Procurement and installation of 4 cylinders manifold systems	For a centralized oxygen delivery in a facility	pc	1	11,500,000	1,009	11,603,500,000	5,045,000	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
		TOTAL						**69,358,660,000**	**30,155,939**	
	OXYGEN PRODUCTION AT DISTRICT HOSPITAL LEVEL	Procurement of 100 type J oxygen cylinders	Half the number of Cylinders to be in use and the rest half of cylinders under supply chain management	PC	100	460,000	190	8,740,000,000	3,800,000	144 Government owned and 168 Private owned facilities
		Procurement of 50 wall mounted cylinder racks	Each rack will be used for mounting each cylinder	pc	50	100,000	190	950,000,000	413,043	
		Procurement of 5 type D oxygen cylinders	The cylinders will be used for inter - and intra facility patient transfer	pc	5	230,000	190	218,500,000	95,000	
		Procurement of 15 oxygen concentrators	The oxygen concentrators will be used for each facility as a backup in case of shortage	pc	15	4,332,900	190	12,348,765,000	5,369,028	
		Procurement of 50 oxygen cylinder flowmeters	The cylinder flowmeters be used, in case the pipe network has any fault	pc	50	325,100	190	3,088,450,000	1,342,804	
		Procurement and installation of PSA plants with capacity to fill 100 cylinders	For a centralized oxygen production, delivery and filling of cylinders within a facility	pc	1	600,000,000	190	114,000,000,000	49,565,217	For strategically located hospitals, Number to be determined. 10 prioritized district Hospitals
		Procurement and installation of 10 cylinders manifold systems	For a centralized oxygen delivery in a facility	pc	1	11,500,000	190	2,185,000,000	950,000	
		TOTAL						**141,530,715,000**	**61,535,093**	
	OXYGEN PRODUCTION AT REGIONAL HOSPITAL LEVEL	Procurement of 240 type J oxygen cylinders	Half the number of Cylinders to be in use and the rest half of cylinders under supply chain management	pc	240	460,000	29	3,201,600,000	1,392,000	28 Government owned and 27 private owned facilities
		Procurement of 120 wall mounted cylinder racks	Each rack will be used for mounting each cylinder	pc	120	100,000	29	348,000,000	151,304	
		Procurement of 10 type D oxygen cylinders	The cylinders will be used for inter - and intra facility patient transfer	pc	10	230,000	29	66,700,000	29,000	
		Procurement of 120 oxygen cylinder flowmeters	The cylinder flowmeters be used, in case the pipe network has any fault	pc	120	325,100	29	1,131,348,000	491,890	
		Procurement and installation of PSA plants with capacity to fill 200 cylinders	For a centralized oxygen production, delivery and filling of cylinders within a facility	pc	1	600,000,000	29	17,400,000,000	7,565,217	
		Procurement and installation of 20 cylinders manifold systems	For a centralized oxygen delivery in a facility	pc	1	11,500,000	29	333,500,000	145,000	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
		SUBTOTAL						**22,481,148,000**	**9,774,412**	
	OXYGEN PRODUCTION AT ZONAL REFERRAL HOSPITAL LEVEL	Procurement of 480 type J oxygen cylinders	Half the number of Cylinders to be in use and the rest half of cylinders under supply chain management	pc	480	460,000	5	1,104,000,000	480,000	
		Procurement of 480 wall mounted cylinder racks	Each rack will ne used for mounting each cylinder	pc	480	100,000	5	240,000,000	104,348	
		Procurement of 20 type D oxygen cylinders	The cylinders will be used for inter - and intra facility patient transfer	pc	20	230,000	5	23,000,000	10,000	
		Procurement of 240 oxygen cylinder flowmeters	The cylinder flowmeters be used, in case the pipe network has any fault	pc	120	325,100	5	195,060,000	84,809	
		2000 lts liquid oxygen (LOX) tank with its accessories for secondary supply	The supply of liquid oxygen for back up in case of PSA plant breakdown or below capacity production etc	pc	1	62,100,000	5	310,500,000	135,000	
		Procurement and installation of PSA plants with capacity to fill 200 cylinders	For a centralized oxygen production, delivery and filling of cylinders within a facility	pc	1	600,000,000	5	3,000,000,000	1,304,348	
		Procurement and installation of 20 cylinders manifold systems	For a centralized oxygen delivery in a facility	pc	7	11,500,000	5	402,500,000	175,000	The size f the facility will determine the number of manifold systems eg departmental
		SUBTOTAL						**5,275,060,000**	**2,293,504**	
	OXYGEN PRODUCTION AT SPECIALIZED REFERRAL HOSPITAL LEVEL	Procurement of 240 type J oxygen cylinders	Half the number of Cylinders to be in use and the rest half of cylinders under supply chain management	pc	240	460,000	6	662,400,000	288,000	
		Procurement of 120 wall mounted cylinder racks	Each rack will be used for mounting each cylinder	pc	120	100,000	6	72,000,000	31,304	
		Procurement of 20 type D oxygen cylinders	The cylinders will be used for inter - and intra facility patient transfer	pc	10	230,000	6	13,800,000	6,000	
		Procurement of 120 oxygen cylinder flowmeters	The cylinder flowmeters be used, in case the pipe network has any fault	pc	120	325,100	6	234,072,000	101,770	
		Procurement and installation of PSA plants with capacity to fill 200 cylinders	For a centralized oxygen production, delivery and filling of cylinders within a facility	pc	1	600,000,000	6	3,600,000,000	1,565,217	
		Procurement and installation of 20 cylinders manifold	For a centralized oxygen delivery in a facility	pc	1	11,500,000	6	69,000,000	30,000	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
		systems								
		SUBTOTAL						**4,651,272,000**	**2,022,292**	
	OXYGEN PRODUCTION AT NATIONAL HOSPITAL LEVEL	Procurement of 480 type J oxygen cylinders	Half the number of Cylinders to be in use and the rest half of cylinders under supply chain management	pc	480	460,000	1	220,800,000	96,000	
		Procurement of 480 wall mounted cylinder racks	Each rack will be used for mounting each cylinder	pc	480	100,000	1	48,000,000	20,870	
		Procurement of 50 type D oxygen cylinders	The cylinders will be used for inter - and intra facility patient transfer	pc	50	230,000	1	11,500,000	5,000	
		Procurement of 240 oxygen cylinder flowmeters	The cylinder flowmeters be used, in case the pipe network has any fault	pc	240	325,100	1	78,024,000	33,923	
		2000 lts liquid oxygen (LOX) tank with its accessories for secondary supply	The supply of liquid oxygen for back up in case of PSA plant breakdown or below capacity production etc	PC	1	414,000,000	1	414,000,000	180,000	
		Procurement and installation of PSA plants with capacity to fill 200 cylinders	For a centralized oxygen production, delivery and filling of cylinders within a facility	pc	1	600,000,000	1	600,000,000	260,870	
		Procurement and installation of 20 cylinders manifold systems	For a centralized oxygen delivery in a facility	pc	10	11,500,000	1	115,000,000	50,000	The size f the facility will determine the number of manifold systems eg departmental
		SUBTOTAL						**1,487,324,000**	**646,663**	
TOTAL COST FOR MEDICAL OXYGEN SOURCES AND PRODUCTION								**429,365,673,000**	**186,680,727**	
2. INTER - & INTRA FACILITY MEDICAL OXYGEN TRANSPORTATION										
1	Transportation of medical oxygen product	Procurement of 55 oxygen cylinders transportation trucks	The trucks are intended to be used for transportation of oxygen cylinders from the production site to the inquiring healthcare facilities	pc	55	400,000,000	1	22,000,000,000	9,565,217	To be located at the oxygen production site
		Procurement of 7 liquid oxygen transportation trucks	The trucks are intended to be used for transportation of the liquid oxygen from the production site to the healthcare facility most likely zonal and hard to reach facilities due to rains	pc	1	500,000,000	7	3,500,000,000	1,521,739	To be located at the zonal referral Hospitals

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			or any other factors							
2	Piping of oxygen delivery nextworks	Dispensary level at least 6 outlets, 35 OD X 1.00mm, with Munsen Ring copper size	The length of the copper pipes determine the number of outlets in reference to hospital bed distances	No. of outlets	6	4,140,000	5,409	134,359,560,000	58,417,200	The cost estimate for eac outlet is estimated to 1800 USD for each outlet
		Health center level at least 20 outlets, 5 OD X 1.00mm copper size	The length of the copper pipes determine the number of outlets in reference to hospital bed distances	No. of outlets	20	4,140,000	667	55,227,600,000	24,012,000	
		District Hospital level at least 50 outlets, 5 OD X 1.00mm copper size	The length of the copper pipes determine the number of outlets in reference to hospital bed distances	No. of outlets	50	4,140,000	144	29,808,000,000	12,960,000	
		Regional referral Hospital level at least 120 outlets, 5 OD X 1.00mm copper size	The length of the copper pipes determine the number of outlets in reference to hospital bed distances	No. of outlets	120	4,140,000	28	13,910,400,000	6,048,000	
		Specialized Hospital referral Hospital level at least 120 outlets, 2 5 OD X 1.00mm copper size copper size	The length of the copper pipes determine the number of outlets in reference to hospital bed distances	No. of outlets	120	4,140,000	6	2,980,800,000	1,296,000	
		Zonal referral Hospital level at least 240 outlets, 22 OD X 1.0mm copper size	The length of the copper pipes determine the number of outlets in reference to hospital bed distances	No. of outlets	240	4,140,000	5	4,968,000,000	2,160,000	
		National Hospital level at least 240 outlets, 22 OD X 1.0mm copper size	The length of the copper pipes determine the number of outlets in reference to hospital bed distances	No. of outlets	240	4,140,000	1	993,600,000	432,000	The size of the facility will determine the number of outlets
		SUB TOTAL						**267,747,960,000**	**116,412,157**	
TOTAL COST FOR INTER - & INTRA FACILITY MEDICAL OXYGEN TRANSPORTATION								**267,747,960,000**	**116,412,157**	
3. IMPLEMENTATION ACTIVITIES FOR OXYGEN SCALE-UP COORDINATION										
1	i. To revise national policy guidelines, and standard	Conduct five day workshop to revise national policy guideline and SOPs for medical	Five day workshop will be conducted in any selected Region. This will involve the following participants	Per diems (MoH)	5	120,000	6	3,600,000	1,565	Representative from MoH shall involve 1 participants from QI unit
				Per diem (PORALG)	5	120,000	6	3,600,000	1,565	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
	operating procedures (SOPs) for medical oxygen production, distribution, and use.	oxygen (production, distirbution and use)	(MOH=5; POLARG=5; RHMT(RHCTSco= 3, REMCo= 3) Partners= 8; Drivers=8(MoH=2, PORALG=2, RHMT=3, Academic staff=1); Supportive staff=3), Academic Staff= 2, Health facilities representative (Clinician, Nurse & Biomedical Engineer) =9	Per diem (RHMTs)	6	120,000	6	4,320,000	1,878	
				Per diem (Health facilities representative)	9	120,000	6	6,480,000	2,817	
				Per diem (Academic staff)	2	120,000	6	1,440,000	626	
				Per diem (Drivers)	8	100,000	6	4,800,000	2,087	
				Per diem (Supportive staff)	3	120,000	6	2,160,000	939	
				Per diem (Partners)	8	-	6	-	-	
				Bus fair	9	70,000	2	1,260,000	548	
				Conference package	46	60,000	5	13,800,000	6,000	
				Fuel for m/vehicles	350	3,500	8	9,800,000	4,261	the farthest region from Dodoma used as reference for computing litres of fuel
				SUB-TOTAL				**51,260,000**	**22,287**	
2		Conduct work shop to revise Assessment Tool/checklist for coordination of medical oxygen production, storage transportation, supply, utilization.	A five (5) day workshop will be conducted at National level, aiming to develop a comprehensive Assessment Tool - a package of several checklists - which will track useful information/data in regard to medical oxygen demand, production, storage, supply / transportation system & utilization for decision making at different health administrative level. **Participants** will include: MoH (DEPRU=1; CMX=1; BME=1, Logistics & Supply=1; Coordination FP=1); Private Supplier=2; Partners=4; Army=2; Representatives	Per diem (MoH)	5	120,000	6	3,600,000	1,565	
								-	-	
				Per diem (Army)	2	120,000	6	1,440,000	626	
				Per diem (R/CHMTs)	4	120,000	6	2,880,000	1,252	
				Per diem(HF representatives)	4	120,000	6	2,880,000	1,252	
				Partners	4	-	-	-	-	
				Per diem (PORALG)	3	120,000	6	2,160,000	939	
				per diem (Drivers)	3	100,000	6	1,800,000	783	
				Conference Package	25	60,000	5	7,500,000	3,261	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			R/CHMTs=4; Users (HF staff)=4,PORALG=3 and other supporting staff (Drivers =3)	Bus Fair	12	70,000	2	1,680,000	730	
				Fuel	246	3,500	2	1,722,000	749	
								25,662,000	**11,157**	
		conduct Training of trainers for the dissemination of Assessment Tool/checklist for coordination of medical oxygen production, storage transportation, supply, utilization.	A five (5) day training of trainers that will be used for dissemination meetings at different health administrative levels for Assessment Tool/checklist for coordination of medical oxygen production, storage transportation, supply, utilization. Parcipants - MoH (EPRU=2, PSU=1, ICT=1, TMDA=1), PORALG=1, Master trainers=4, Trainees =25, Partners=2, Supportive staff =2, Drivers=2	Per diem (MoH)	4	120,000	6	2,880,000	1,252	
				Per diem (TMDA)	1	120,000	6	720,000	313	
				Per diem (Master trainer)	4	120,000	6	2,880,000	1,252	
				Per diem (Trainee)	25	120,000	6	18,000,000	7,826	
				Per diem (Supportive staff)	2	120,000	6	1,440,000	626	
				Partners	2	-	-	-	-	
				Per diem (PORALG)	1	120,000	6	720,000	313	
				per diem (Drivers)	2	100,000	6	1,200,000	522	
				Conference Package	41	60,000	5	12,300,000	5,348	
				Bus Fair	26	70,000	2	3,640,000	1,583	
				Fuel	164	3,500	2	1,148,000	499	
			SUB -TOTAL					**44,928,000**	**19,534**	
		Conducting printing of national policy guidelines & SOPs for medical oxygen, Assessment Tool/checklist for coordination of medical oxygen production, storage transportation, supply, utilization.	A total of 20465 copies of medical oxygen national policy guideline will be printed. In align with this a total ……SOPs will be printed as well. National Policy Guideline Copies (National Hospital=1, Specialized Hospital=5, Zonal Hosp=7, RRH=,29 District Hosp=190, H/C= 1,009, Dispensary=6,301	Printing (National Policy Guideline)	20465	10,000	1	204,650,000	88,978	National Hosp will have 20 copies, Specialized Hosp, Zonal Hosp, RRH & District Hosp 10 copies each, H/C 5 copies each, Dispensary 2 copies each, RHMT 2 copies each, CHMT 2 copies each
				Printing (Standard Operating Procedure)	20,465	5,000	1	102,325,000	44,489	National Hosp will have 10 copies, Specialized Hosp, Zonal Hosp, RRH & District Hosp 10 copies each, H/C 5 copies each, Dispensary 2 copies each, RHMT 2 copies each, CHMT 2 copies each

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
				Printing (Comprehensive assessment tool/checklist booklet)	19997	5,000	1	99,985,000	43,472	National Hosp will have 10 copies, Specialized Hosp, Zonal Hosp, RRH & District Hosp 10 copies each, H/C 5 copies each, Dispensary 2 copies each.
								406,960,000	**176,939**	
		Conduct workshop to incorporate Assessment Tool/checklist for coordination of medical oxygen production, storage transportation, supply, utilization into AfyaSS system.	A two (2) day workshop will be conducted to update and incorporate revised assessment Tool/Checklist for coordination of medical oxygen into AfyaSS based on new updates from the revised version. Participants: MoH (EPRU=2, ICTO=2) PORALG=1, RHMT=2, CHMT=2, HF representative=2	Per diem (MoH & PORALG)	5	120,000	3	1,800,000	783	
				Per diem (R/CHMT))	4	60,000	3	720,000	313	
				Per diem (HF Representative)	2	60,000	2	240,000	104	
				Per diem (Drivers)	3	100,000	3	900,000	391	
				Refreshments	14	30,000	2	840,000	365	
				Venue	1	200,000	2	400,000	174	
				Fuel for MoH & PORALG vehicles	225	3,500	2	1,575,000	685	
								6,475,000	**2,815**	
		Conduct dissemination meeting for the developed Assessment Tool /checklists for Medical Oxygen coordination at National level	A two (2) day dissemination meeting will be conducted at National level, participants - MoH(EPRU =4, HTSU=2, PSU =3, ICT=2, PMU=2, DPP =2), TMDA=2, Partners =5, PORALG=4	Per diem (MoH)	15	120,000	3	5,400,000	2,348	
				Per diem (TMDA)	2	120,000	3	720,000	313	
				Per diem (Master trainer)	4	120,000	3	1,440,000	626	
				Per diem (Supportive staff)	1	120,000	3	360,000	157	
				Partners	5	-	-	-	-	
				Per diem (PORALG)	4	120,000	3	1,440,000	626	
				per diem (Drivers)	6	100,000	3	1,800,000	783	
				Conference Package	37	60,000	2	4,440,000	1,930	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
				Fuel	492	3,500	2	3,444,000	1,497	
			SUB -TOTAL					**19,044,000**	**8,280**	
		Conduct dissemination meeting for the developed Assessment Tool /checklists for Medical Oxygen coordination at Regional level & Dissemination of National policy guidelines & SOPs for medical oxygen.	A three (3) day dissemination meeting will be conducted at Regional level, Participants- RHMT (RMO, RHS, RPHARM, RQIFP, RHCTSco, REMCo, RNO, RCSCo), CHMT(DMO, DHS, DPHARM, DQIFP,DEMCo, DNO,DCSCo, DHCTSco), Partners=5, Health faclities - Clinician, Nurse, and Biomedical Engineer (National Hosp=3, Zonal Hosp=3, Regional Hosp=3, Specialized Hosp=3, District Hosp=3), National Faciliatator =2, Drivers =3	Per diem (RHMT)	208	120,000	5	124,800,000	54,261	All 26 regions included(Tz Mainland)
				Per diem (CHMT)	1664	120,000	5	998,400,000	434,087	An average of 8 Council per region
				Per diem (Health Facilities representative)	390	120,000	5	234,000,000	101,739	
				Per diem (National Facilitator)	52	120,000	5	31,200,000	13,565	
				Partners	130	-	-	-	-	
				per diem (Drivers)	260	100,000	5	130,000,000	56,522	1driver for MoH, 1 Driver for RHMT and 8 Drivers for CHMT
				Conference Package	2704	60,000	4	648,960,000	282,157	
				Fuel (MoH) Vehicle	7800	3,500	1	27,300,000	11,870	An average use of 300 litres fuel for MoH vehicle
				Fuel (R/CHMT) Vehicle	20800	3,500	1	72,800,000	31,652	An average use of 100 litres fuel for R/CHMT Vehicles
				SUB -TOTAL				**2,267,460,000**	**985,852**	
	To establish a sustainable financial system to meet the goals set in the roadmap	Establish National Medical Oxygen Coordinating Body (NMOCC).	To ensure sustainable financial mechanism the MoH (DPERU) will conduct **three-day** meeting to establish National Medical Oxygen Coordinating Committee (NMOCC). Among other roles the NMOCC will be a leading instrument for overall medical oxygen policy implementation in the country as well as solicit funding for sustainability. NMOCC will be chaired by CMO will consist at least **30** members **(EPRU=2; PORALG=2; BME=2; Logistic & Supply=2;**	Per diems (MoH)	12	120,000	5	7,200,000	3,130	
				Per diem (PORALG)	2	120,000	5	1,200,000	522	
				Per diem (R/CHMTs)	6	120,000	5	3,600,000	1,565	
				Per diem (Drivers)	10	100,000	5	5,000,000	2,174	
				Per diem (Supportive staff)	3	120,000	5	1,800,000	783	
				Conference package	33	60,000	3	5,940,000	2,583	
				Fuel for m/vehicles	5,000	3,500	1	17,500,000	7,609	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			Surveillance=2; ICT=2; SWO=2; Dev partners=8; Representatives oxygen suppliers private sector=2 & R/CHMTs=6)							
				SUB-TOTAL				**42,240,000**	**18,365**	
		Conduct **NMOCC** Bi-annual meeting	Three -day bi-annual NMOCC meeting will gather all co-members to discuss issues related to medical oxygen in the country. This will be an opprotunity for entire team to review Regional implementation reports- *achievements, challenges, wayfoward and the lesson learned.*	Per diems (MoH)	12	120,000	10	14,400,000	6,261	
				Per diem (PORALG)	2	120,000	10	2,400,000	1,043	
				Per diem (R/CHMTs)	6	120,000	10	7,200,000	3,130	
				Per diem (Drivers)	10	100,000	10	10,000,000	4,348	
				Per diem (Supportive staff)	3	120,000	10	3,600,000	1,565	
				Conference package	33	60,000	6	11,880,000	5,165	
				Fuel for m/vehicles	5,000	3,500	2	35,000,000	15,217	
				SUB-TOTAL				**84,480,000**	**36,730**	
		Conduct Regional Sensitization meeting to establish Regional Medical Oxygen Coordinating Body (RMOCC)	To ensure sustainability and regular monitoring of medical oxygen interventions at all level. The NMOCC members in collaboration with RMOs & RHCTS-Coordinator will conduct One-day sensitization meeting to establish Regional Medical Oxygen Coordinating Body in 26 Regions. A team of Three members lead by PORALG representative will pay visit to respective Region to establish functioning committee. One-day sensitization meeting will be chaired by RMO, attended by CHMT	Per diems (NMOCC members)	78	120,000	3	28,080,000	12,209	
				Per diem (PORALG)	26	120,000	3	9,360,000	4,070	
				Per diem (RHMTs- **RMO, RHCTS-coord,RICT-officer,RHS**)	104	60,000	1	6,240,000	2,713	
				Per diem (CHMT- **DMOs, DHCTS-coord)**	416	120,000	3	149,760,000	65,113	
				Per diem (Drivers)	208	100,000	3	62,400,000	27,130	
				Venue	26	200,000	1	5,200,000	2,261	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			members of the respective Region to ensure buy in of the same idea at Council level. Roles and responsibilities will be described as well.	Refreshments	598	30,000	1	17,940,000	7,800	
				Fuel MOH m/vehicles	7,800	3,500	2	54,600,000	23,739	
				Fuel CHMTs m/vehicles	10,400	3,500	2	72,800,000	31,652	
				Stationaries	390	6,000	1	2,340,000	1,017	
				SUB-TOTAL				**408,720,000**	**177,704**	
		Conduct Quarterly Regional Medical Oxygen Coordinating Body (RMOCC) meeting.	Two day quarterly RMOCC meeting will be held at one of the selected Council (host Council) on rotation basis to promote smooth & active participation. Chaired by **RMO, RHCTS-coordinator** Secretary, the meeting will gather **RMOCC members** of respective Regions *(1-RMO, 1-RHTCS-coord, 1-RHS, 1-RICT-officer,1-DMO/council, 1-DHCTS-coordinator/council, 1-DHS/council, 1-ICT-officer/council).* All *a*genda in regard to medical oxygen production, storage, transportation and utilization will be discussed. None the less the team will also discuss **Medical Equipment Maintenance (MEM) & Sustainability** from their catchment areas including PSA plants.	Per diem (RHMTs)	32	120,000	16	61,440,000	26,713	
				Per diem (CHMTs)	32	120,000	16	61,440,000	26,713	
				Per diem (Drivers RCHMTs)	72	100,000	16	115,200,000	50,087	
				Venue	8	200,000	64	102,400,000	44,522	
				Refreshments	136	30,000	64	261,120,000	113,530	
				Fuel CHMTs m/vehicles	800	3,500	4	11,200,000	4,870	each Council will use 50 litres of Fuel
				Fuel CHMTs m/vehicles	10,400	3,500	4	145,600,000	63,304	each region will have an estimated of 50 Litres to and fro
				Stationaries	64	6,000	4	1,536,000	668	
				SUB-TOTAL				**759,936,000**	**330,407**	
TOTAL COST FOR IMPLEMENTATION OF ACTIVITIES ON OXYGEN SCALE-UP COORDINATION								**4,117,165,000**	**1,790,072**	
4. MEDICAL EQUIPMENT MANAGEMENT (MEM) AND MEDICAL OXYGEN SUPPLY SUSTAINABILITY										
	MEIMIS & supportive	Conduct training on Medical Equipment	Five-day training on Medical Equipment &	Per diem (National	104	120,000	7	87,360,000	37,983	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
	supervision, Advocacy & mentorship activities	Management (MEM).	Infrastructure Management System (MEIMIS) will target following participants: RMO, RHS, RICT-Officer, RPHARM, REMCo, RQIFP, RHCTS-coordinator; Zonal Hospital- MOI, BME; ICTO; EMCo RRH-MOI, BME; ICTO; EMCo; CHMTs-DMO; MOI; BME; ICTO; QIFP; EMCo; DPHARM, National Facilitator =4, H/C=MOI, BME/Technician. Specialized Hospital= MOI, BME, ICTO, EMCo, National Hospital=ED, BME, EMCo, ICTO.	Facilitator)						
				Per diem (RHMTs)	156	120,000	7	131,040,000	56,974	
				Per diem (CHMTs)	1456	120,000	7	1,223,040,000	531,757	
				Per diem (Zonal Hospital)	36	120,000	7	30,240,000	13,148	
				Per diem (Regional Referral Hospital)	116	120,000	7	97,440,000	42,365	
				Per diem (Health Centre)	2018	120,000	7	1,695,120,000	737,009	
				Per diem (Specialized Hosp)	20	120,000	7	16,800,000	7,304	
				Per diem (National Hosp)	4	120,000	7	3,360,000	1,461	
				Per diem (Drivers)	2,080	100,000	7	1,456,000,000	633,043	26 drivers for 26 RHMT, Drivers for 8 Councils, 9 drivers for 9 Zonal Hosp, 29 Drivers for 29 RRH,and 1 Driver for National Hosp, 5 drivers for specialized,
				Refreshment	5,990	30,000	5	898,500,000	390,652	
				Venue	52	500,000	5	130,000,000	56,522	
				Fuel (RHMT/CH,T/HF)	20,800	3,500	1	72,800,000	31,652	The Fuel will support RHMT, CHMT, National Hosp, Specialized Hosp, Zonal Hosp, RRH and H/C vehicles
				Fuel (National Facilitator)	7,800	3,500	1	27,300,000	11,870	Each region will have an estimated of 300 Litres to and fro
				Stationaries	3,910	6,000	1	23,460,000	10,200	
			SUB - TOTAL					**5,892,460,000**	**2,561,939**	
		Conduct Supportive supervision & mentorship for medical equipment management	A five (5) day Quarterly MEM supportive supervision & mentorship to capacitate providers on proper MEM and minor trouble shooting. Participants: RHMT = RMO, REMCo,	Per diem(MoH & PORALG)	416	120,000	32	1,597,440,000	694,539	The two officers each from MoH & PORALG will share same vehicle to reduce cost
				Per diem (RHMTs)	1040	120,000	28	3,494,400,000	1,519,304	
				Per diem (CHMTs)	1040	60,000	24	1,497,600,000	651,130	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			RHCTSCo, RQIFP, RPHARM, CHMT= DMO, DEMCo, DHCTSCo, DQIFP, DPHARM. Drivers = 9 , MoH & PORALG=2	Per diem (Driver MoH &PORALG)	208	100,000	32	665,600,000	289,391	
				Per diem (Drivers RHMT)	208	100,000	28	582,400,000	253,217	
				Per diem (Drivers CHMT)	1664	50,000	24	1,996,800,000	868,174	
				Fuel (RHMT)	7800	3,500	4	109,200,000	47,478	Each Region will be supported with 300 litres of fuel for RHMTs.
				Fuel (CHMT)	41600	3,500	4	582,400,000	253,217	Each Council will be supported with 200 litres of fuel for CHMTs.
				Fuel (MoH &PORALG)	124800	3,500	4	1,747,200,000	759,652	MoH and PORALG will be supported with 600 litres of fuel for every region.
								12,273,040,000	**5,336,104**	
		Procurement of vehicle to support Regional on routing follow up of medical oxygen	One (1) vehicle per region will be procured to support the Region in coordinating routing follow up of Medical Oxygen.	Procurement	26	90,000,000	1	2,340,000,000	1,017,391	The Toyota Hilux double cabin (Manual) will be procured for each region
				Fuel	7800	3,500	4	109,200,000	47,478	Each regional vehicle will use 300 litres per quarter
				Vehicle maintenance (30% of fuel price)				32,760,000	14,243	30%of fuel price shall be used for vehicle maintenance
				SUB -TOTAL				**2,481,960,000**	**1,079,113**	
		Conduct Planned Preventive Maintenance (PPM)	PPM will be conducted on quarterly basis. A team of BME/Technicians will pay visit to HF for preventive maintenance. The budget will include cost for procurement of spare parts and other related supplies for preventive maintenance.	Venue	52	500,000	5	130,000,000	56,522	
				Fuel (RHMT/CH,T/HF)	20,800	3,500	1	72,800,000	31,652	
								202,800,000	**88,174**	
GRAND TOTAL COST FOR MEDICAL EQUIPMENT MANAGEMENT (MEM) AND MEDICAL OXYGEN SUPPLY SUSTAINABILITY								**20,850,260,000**	**9,065,330**	
5:HEALTHCARE WORKERS CAPACITY BUILDING (TRAINING, MENTORING AND SUPERVISION)										
1	To conduct Orientation to biomedical engineers on the	A three days activity on orientation of biomedical engineers or technicians will be	Per diem for participants	person	216	120,000	4	103,680,000	45,078	Considering each facility bring 1 BME from National to RRH levels, total 46 BME, Activity will be conducted in Arusha.

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
	new installed oxygen plants and its equipment	conducted involving one expert from national to council level (from national, zonal ,speacilized,RRH and MOH (MOH-2,MNH-1,ZONAL-6,Specialized-8 and RRH-29)	Supportive staffs	Persons	1	100,000	4	400,000	174	
			Trainers	Persons	3	120,000	12	4,320,000	1,878	4 trainers to orient BME
			Drivers	Persons	2	100,000	12	2,400,000	1,043	
			Conference package	Lump sum	222	60,000	9	119,880,000	52,122	Conference package per head/ day 60,000
			Fuel	litres	334	3,500	3	3,507,000	1,525	Meeting will be conducted in Arusha, estimated 500km from Dodoma.
			Ground transport	transport refund	180	50,000	2	18,000,000	7,826	Bus fare estimated to be 50,000
			On transit	person	222	60,000	2	26,640,000	11,583	On transit cost 60,000 for travel more than 6 hours.
			Printing cost	Lump sum	1	200,000	3	600,000	261	
				SUBTOTAL				**279,427,000**	**121,490**	
	To conduct training to HCWs on proper oxygen use	Training of regional TOT	4 trainers from MOH/partners to train 4 RHMT from each region	per diem	8	120,000	120,000	115,200,000,000	50,086,957	2 trainings will be done by dividing in 2 zones, one in Morogoro and another in Mwanza, each will be conducted for 3days
			4 RHMTs from each region	per diem	104	120,000	4	49,920,000	21,704	26 regions each with 4 members
			Conference package	per diem	112	60,000	3	20,160,000	8,765	Conference package per head/ day 60,000
			On transit	per diem	112	60,000	2	13,440,000	5,843	ON transit cost 60,000 for travel more than 6 hours.
			Drivers	per diem	2	100,000	4	800,000	348	1 driver each training from the MOH
			Supportive staffs	per diem	2	100,000	4	800,000	348	1 supportive staff for each training from the MOH
			Fuel	Litres	334	3,500	2	2,338,000	1,017	Meeting will be conducted in Morogoro and Mwanza, estimated 500km from Dodoma
			Printing cost	Lump sum	2	200,000	1	400,000	174	Printing cost 200,000 each
			Ground transport	return ticket	112	50,000	2	11,200,000	4,870	Ground transport will be paid to all participants with exclusion of drivers and supportive staffs expected to be using the MOH's vehicles.
		Sub-total						**115,299,058,000**	**50,130,025**	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
		ii. Training of 3 HCWs from each facility	3 HCW from each facilities trained on trouble shooting, proper management/administration of oxygen to clients and Essential emergency care in their respective District	per diem	22629	80,000	3	5,430,960,000	2,361,287	7543 Facilities each giving 3 Participants for 3 days training
			4 RHMT to train HCW in 139 District in the country (184 councils)	per diem	104	100,000	16	166,400,000	72,348	4 RHMTs to train in 139 districts
			On transit	per diem	104	50,000	2	10,400,000	4,522	On transit cost 50,000 for travel more than 6 hours, within same region, For RHMT members only.
			Supportive staffs	per diem,	26	100,000	16	41,600,000	18,087	1 supportive staff for each training(139 in total)
			Conference package	Lump sum	22759	35,000	3	2,389,695,000	1,038,998	Conference package per head/ day 35,000, sum of all HCW, trainers and supportive staffs times 5 days
			Printing cost	Lump sum	184	200,000	4	147,200,000	64,000	Printing cost 200,000 each session, each council will conduct at least four (4) sessions
			Fuel for the trainers	litres	200	3,500	184	128,800,000	56,000	Each team to the council will need 200 litres for the 4 sessions of the training
			Ground transport	return ticket	22629	10,000	2	452,580,000	196,774	For 4 RHMT members within their region, estimated 10,000 per trip
Sub -Total								**8,767,635,000**	**3,812,015**	
3	To conduct supervision on oxygen supply chain	I. To prepare supervision checklist	3 BME, 3 clinicians, 2 Supportive staff and 2 others as per needs	per diem	10	120,000	4	4,800,000	2,087	Meeting will be conducted in Arusha for 3 days
			Drivers	per diem	3	1,000,000	4	12,000,000	5,217	3 drivers for the 12 officials
			Fuel	Litres	350	3,500	3	3,675,000	1,598	
			Printing cost	Lump sum	1	200,000	1	200,000	87	1 session for the supervision checklist development
			On transit	per diem	15	60,000	2	1,800,000	783	On transit cost 60,000 for travel more than 6 hours.
			Conference package	Lump sum	15	60,000	3	2,700,000	1,174	Conference package per head/ day 60,000
			Support staff	per diem	2	100,000	4	800,000	348	On transit cost 60,000 for travel more than 6 hours.
SUB - TOTAL								**3,336,675,000**	**107,895,374**	
	Oxygen Guideline and	To conduct a two (2) days dissemination	Per diem for National Facilitators	Per diem	12	120,000	2	2,880,000	1,252	3 facilitators will be conducting the training for 2days, the sessions will be

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
	SOPs Dissemination Meeting-Dodoma	meeting to the RHMT & CHMT Members								dived into 4
			Per diem for RMO	Per diem	26	120,000	3	9,360,000	4,070	26 RMOs from all the regions will be engaged
			Per diem for DMOs	Per diem	184	120,000	3	66,240,000	28,800	All DMOs & TMOs from 184 councils
			Per diem for RNO	Per diem	26	120,000	3	9,360,000	4,070	
			Per diem for MOI	Per diem	212	120,000	3	76,320,000	33,183	MOIs form RRHs and Council Hospitals
			Per diem for NOI	Per diem	212	120,000	3	76,320,000	33,183	RRHs and council Hospitals
			Per diem for Biomedical Engineer	Per diem	26	120,000	3	9,360,000	4,070	One biomedical Engineer from each region
			Per diem for RHO	Per diem	26	120,000	3	9,360,000	4,070	
			Per diem for RHS	Per diem	26	120,000	3	9,360,000	4,070	
			Per diem for RQIFP	Per diem	26	120,000	3	9,360,000	4,070	
			Per diem for RRHQAFP	Per diem	26	120,000	3	9,360,000	4,070	
			Per diem for HS	Per diem	26	120,000	3	9,360,000	4,070	
			Per diem for Procurement Officers	Per diem	26	120,000	3	9,360,000	4,070	
			Per diem for drivers	Per diem	422	100,000	3	126,600,000	55,043	Driver for RMO, MOI, and 7 DMOs
			Per diem for DICTO	Per diem	184	120,000	3	66,240,000	28,800	
			Per diem for DNO	Per diem	184	120,000	3	66,240,000	28,800	
			Per diem for D/HS	Per diem	184	120,000	3	66,240,000	28,800	
			Per diem for DHO	Per diem	184	120,000	3	66,240,000	28,800	
			Per diem for DQIFP	Per diem	184	120,000	3	66,240,000	28,800	
			Travel refund	Transport Fare refund	549	50,000	2	54,900,000	23,870	At least a quarter the number of participants will travel by public transport

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			Conference package	Package per person	2196	60,000	2	263,520,000	114,574	
			Fuel for RMO, DMOs and MOI	Fuel	126600	3,500	1	443,100,000	192,652	An average of 300 litres for each vehicle
			Fuel for National Facilitators	Fuel	560	3,500	1	1,960,000	852	
SUB TOTAL								**1,527,280,000**	**664,035**	
TOTAL COST FOR HEALTHCARE WORKERS CAPACITY BUILDING (TRAINING, MENTORING AND SUPERVISION)								**129,210,075,000**	**56,178,293**	
6. MONITORING & EVALUATION										
1	To develop biananul National Medical Oxygen Supply Scaling-up Plan Implementation progress report	Develop biannual scale up plan implementation progress report	The activity will be conducted at each level, from council and regional level, a three (3) days' workshop for at least 6 participants will be spared for developing a report that will be submitted to the national level	Per diem - participants	12	60,000	552	397,440,000	172,800	The workshop will be conducted twice per year at council level only 6 staff for 3 days
				Per diem - Driver	2	50,000	552	55,200,000	24,000	
				Fuel	140	3,500	184	90,160,000	39,200	
				Conference Package	14	60,000	552	463,680,000	201,600	
		SUBTOTAL						**1,006,480,000**	**437,600**	
2	Biannual oxygen supply assessments from lower to the higher level facilities	Development of a facility based comprehensive oxygen supply assessment tool	The activity will be conducted at national level with involvement of council and regional level teams, a five (5) days' workshop for at least 35 participants will be spared for developing the assessment tool. Experts to included are; Biomed, technicians, clinicians, nurses, pharmacist, academia, MOH (Procurement Units, Supplies), PO RALG & Partners	Per diem - participants	32	120,000	6	23,040,000	10,017	The work will be conducted once in Morogoro Region
				Per diem - Driver	2	100,000	6	1,200,000	522	
				Support Staff	1	100,000	6	600,000	261	
				Fuel	100	3,500	2	700,000	304	
				Round trip fuel	20	3,500	5	350,000	152	
				Transport Fare refund	25	50,000	2	2,500,000	1,087	
				Conference package	35	60,000	5	10,500,000	4,565	
				Printing	1	200,000	1	200,000	87	
		SUBTOTAL						**39,090,000**	16,996	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
		Conduct biannual assessment for oxygen supply from lower to higher level facilities to determine the availability, accessibility and reliability, that includes the tracer equipment for maintenance	The activity will be conducted at council, a two (2) days assessment per facility comprising of 6 experts will be conducted. This will include, Facility incharge, Facility biomed/technician/any responsible for oxygen issues, facility matron, a mentored support staff, facility secretary and procurement officer. A report t will be submitted to the national level	Per diem - participants	6	60,000	368	132,480,000	57,600	The assessment will be accompanied by two staff from the CHMT/RHMT (184 council facilities)
				Per diem - participants	3	120,000	552	198,720,000	86,400	Staff from either CHMT
				Per diem - Driver	1	50,000	368	18,400,000	8,000	Local Driver
				Per diem - Driver	1	100,000	552	55,200,000	24,000	Driver for RHMT/CMT
				Fuel	150	3,500	184	96,600,000	42,000	Regional/Council level Fuel
				Fuel	70	3,500	184	45,080,000	19,600	Local vehicle
				Stationeries	9	6,000	184	9,936,000	4,320	For the whole team
				Printing	1	200,000	184	36,800,000	16,000	
			SUBTOTAL					**593,216,000**	257,920	
			The activity will be conducted at regional level, a two (2) days assessment comprising of 6 experts will be conducted. This will include, Facility in charge, Facility biomed/technician/any responsible for oxygen issues, facility matron, a mentored support staff, facility secretary and procurement officer. A report t will be submitted to the national level	Per diem - participants	6	60,000	58	20,880,000	9,078	The assessment will be accompanied by two staff from the CHMT/RHMT (29 RRH facilities)
				Per diem - participants	3	120,000	87	31,320,000	13,617	Staff from either RHMT
				Per diem - Driver	1	50,000	58	2,900,000	1,261	Local Driver
				Per diem - Driver	1	100,000	87	8,700,000	3,783	Driver for RHMT
				Fuel	150	3,500	29	15,225,000	6,620	Regional level Fuel
				Fuel	70	3,500	29	7,105,000	3,089	Local vehicle
				Stationeries	9	6,000	29	1,566,000	681	For the whole team
				Printing	1	200,000	29	5,800,000	2,522	
			SUBTOTAL					**93,496,000**	40,650	
			The national level shall conduct annual assessment of the oxygen systems. This will include experts	Per diem - participants	7	120,000	364	305,760,000	132,939	The assessment will be conducted for at least 14days per region once in a year
				Per diem - Driver	2	100,000	364	72,800,000	31,652	Two drivers from the national level

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			from MOH, PO RALG and Partners for at least 14days per selected facilities in a region	Fuel	500	3,500	26	45,500,000	19,783	No of litres per trip
				Stationeries	9	6,000	26	1,404,000	610	For the whole team
				Printing	1	200,000	26	5,200,000	2,261	
			SUBTOTAL					**430,664,000**	187,245	
			A technical assessment tool will be developed for three days by a team of experts both Biomed, Clinicians, nurses, who shall represent all levels of healthcare, MOH, PO RALG and partners, academia	Per diem - participants	30.00	120,000	4	14,400,000	6,261	
				Printing	1.00	200,000	1	200,000	87	
				Conference package	34.00	60,000	3	6,120,000	2,661	
				Per diem - Driver	4.00	100,000	4	1,600,000	696	
				Fuel	4.00	600,000	1	2,400,000	1,043	
								24,720,000	10,748	
			The activity will be conducted at each level, from council and regional level, a five (5) days assessment shall be conducted for each facility, a minimum of 4 experts per facility shall be involved	Per diem - participants	30000	120,000	2	7,200,000,000	3,130,435	4 participants in every facility(7500 total HF) biannual assessment
				Printing	7500	3,000	1	22,500,000	9,783	3000 per each tool
				Per diem - Driver	5	200	30	30,000	13	40 HF selected in each zone conducting assessment in 15 days
				Fuel	3,000	3,500	2	21,000,000	9,130	3000 litres per trip biannual
			SUBTOTAL					**7,243,530,000**	3,149,361	
5	The RHMT and CHMT supervision checklist to incorporate the elements of HCTS	Review the CHMT/RHMT supervision tool and incorporate the elements of HCTS	The activity will be conducted at each level, from council and regional level, a three (3) days' workshop for at least 35 participants will be spared for reviewing the supervision tool to incorporate the HCTS elements, for both MOH, PO RALG and partners	Per diem - participants	35	120,000	4	16,800,000	7,304	
				Printing	1	200,000	1	200,000	87	
				Conference package	38	60,000	3	6,840,000	2,974	
				Per diem - Driver	3	100,000	4	1,200,000	522	
				Transport	20	35,000	2	1,400,000	609	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
				Fuel	510	3,500	1	1,785,000	776	3 vehicles with a total of 1000km per trip
			SUBTOTAL					**28,225,000**	12,272	
6	To recuit a qualified maintenance technician/engineer and at least one support staff		Permanent/Contract Employment for the experts under Biomedical Engineering or Technician.	Salary per one technician	200	900,000	12	2,160,000,000	939,130	
7	Staff and patients satisfaction Interviews to maintenance status oxygen supply systems and infrastructure and essential amenities	Develop an interview Terms of Reference for the interview or questionnaire	The national level shall review the interview questionnaire, receive and analyze the interview reports on quarterly basis	Per diem - participants	25	120,000	4	12,000,000	5,217	
				Printing	1	200,000	1	200,000	87	
				Conference package	27	60,000	3	4,860,000	2,113	
				Per diem - Driver	2	100,000	4	800,000	348	
				Transport	17	35,000	2	1,190,000	517	
				Fuel	340	3,500	1	1,190,000	517	2 vehicles with a total of 1000km per trip
			SUBTOTAL					**20,240,000**	**8,800**	
8	Plan for outsourced maintenance services according to the suggested packages and the infrastructure	Budget for an outsourced maintenance services according to the suggested packages and the infrastructure	The budget should reflect the annual maintenance cost sufficient for the PPM (at least 20% of the annual budget per facility) this should include also spare parts cost	Budget for maintenance cost				**30,000,000**	**13,043**	
9	Conduct oxygen plant installation impact assessment 4 years after oxygen plant installation to identify health and social-economic impact of oxygen gas accessibility.		Study will be conducted in collaboration with reliable identified university or research institution to evaluate the oxygen plant operations and scale-up, availability, affordability and sustainability of oxygen at all levels of health care to identify areas in need of improvement	1	1	1	70,000,000	70,000,000	30,435	This was will be done by consultant from NIMR or MUHAS/CUHAS etc. (should be mid-term and end term the n to be in cooperated into M& E)
			SUBTOTAL					**70,000,000**	**30,435**	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
TOTAL COST FOR MONITORING & EVALUATION								**9,524,941,000**	**4,141,279**	
7. Improve medical Oxygen usage										
1	DISPENSARY LEVEL	To equip Dispensary level health facilities in all levels with oxygen delivery and monitoring equipment	To procure 3 pulse oximeters	This equipment will be procured quarterly per each level.	3	6,301	90,000	1,701,270,000	739,683	At least 1 pulse oximeter in each section
			To procure 3 wall mounted Flowmeter		3	6,301	160,000	3,024,480,000	1,314,991	At least 1 flow meter per section
			To procure 1 flowmeter for transferring the patient		1	6,301	160,000	1,008,160,000	438,330	
			To procure 30 Nasal Cannula per month		360	6,301	3,000	6,805,080,000	2,958,730	Assumption one patient will use 1 pc per day
			To procure 30 Face Mask per month		30	6,301	3,500	661,605,000	287,654	Assumption one patient will use 1 pc per day
			To procure 3 Oxygen concentrator 10ltrs per dispensary		3	6,301	4,000,000	75,612,000,000	32,874,783	At least 1 per each section
			To procure 1 cylinder valve spanner		1	6,301	20,000	126,020,000	54,791	
			To procure 1 Flowmeter spanner		1	6,301	20,000	126,020,000	54,791	
			To procure 1 Cylinder cart		1	6,301	100,000	630,100,000	273,957	
2	Health center	To equip Health Center level health facilities in all levels with oxygen delivery and monitoring equipment	To procure 7 pulse oximeters		7	1,009	90,000	635,670,000	276,378	At least 1 pulse oximeter per each section
			To procure 7 flowmeter & regulators(for transportation of patients)		7	1,009	160,000	1,130,080,000	491,339	
			To procure 14 wall mounted Flowmeters		14	1,009	160,000	2,260,160,000	982,678	At least 2 wall mounted flowmeters per each section
			To procure 120 Nasal Cannula per month		240	1,009	3,000	726,480,000	315,861	
			To procure 5 Non-rebreather mask per month		60	1,009	7,500	454,050,000	197,413	
			To procure 60 Face Mask per month		120	1,009	3,500	423,780,000	184,252	
			To procure Manifold with 4 cylinders		4	1,009		-	-	
			To procure 2 Cylinder valve key/spanner		2	1,009	20,000	40,360,000	17,548	
			To procure 2 cylinder rack with capacity of 10 cylinders each		2	1,009	155,000	312,790,000	135,996	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	Activities description	Sub-activities	Activity Description/Details	Unit	Quantities	Unit Cost	Frequency/Days	Amount (TZS)	AMOUNT (USD)	Assumptions
			To procure 5 vital sign monitors		5	1,009	850,000	4,288,250,000	1,864,457	
			To procure 4 Cylinder cart		4	1,009	100,000	403,600,000	175,478	
3	District Hospital Level	To equip District Hospital level health facilities in all levels with oxygen delivery and monitoring equipment	To procure 10 pulse oximeters per Hospital		10	190	90,000	171,000,000	74,348	1 pulse oxmeter per each section
			To procure 45 Flowmeters per hospital		45	190	160,000	1,368,000,000	594,783	30 percent of inpatients per day
			To procure 150 Nasal Cannula per month		600	190	3,000	342,000,000	148,696	5 pcs per day
			To procure 60 Non-rebreather mask per month per hospital		720	190	7,500	1,026,000,000	446,087	2 pcs per day
			To procure 900 simple Face Mask per month		10800	190	3,500	7,182,000,000	3,122,609	30 pcs per day
			To procure 8 Cylinder valve spanner per hospital		8	190	20,000	30,400,000	13,217	1 per each section
			To procure 8 Flowmeter spanner per hospital		8	190	20,000	30,400,000	13,217	1 per each section
			To procure 8 Cylinder carts per hospital		8	190		-	-	
			To procure 12 patient's monitors per hospital		12	190	885,000	2,017,800,000	877,304	OT 2, Causality 2, Maternity 2, Male ward 2, Female ward 2, Pediatrics 2
4	Regional Referral Hospital Level	To equip Regional Referral Hospital level health facilities in all levels with oxygen delivery and monitoring equipment	To procure 106 wall mounted flow meters		116	29	160,000	538,240,000	234,017	ICU 24, EMD 16, OT 6, NICU 40, WARDS 36,Assumption is all mentioned beds in respective ward/section will have a patient who is in need of oxygen at per each day
			To procure 12 flowmeter & regulators(for transport)		12	29	160,000	55,680,000	24,209	At least 1 flow meter per 12 service area
			To procure 1500 Nasal prone cannula per month		18000	29	3,000	1,566,000,000	680,870	50 patients will receive oxygen through nasal prongs per day
			To procure 1350 Nonrebreather per month		16200	29	7,500	3,523,500,000	1,531,957	45 pts (1/3 who needs oxygen) expected to use non rebreather face mask per day
			To procure 1500 simple facemask per month		18000	29	3,500	1,827,000,000	794,348	50 patients will receive oxygen through simple face mask per day
			To procure 12 cylinder valve key/spanner per hospital		12	29	20,000	6,960,000	3,026	At least 1 cylinder valve key per each service area
			To procure 12 flow meter spanners		12	29	20,000	6,960,000	3,026	At least 1 per each section
			To procure 12 cylinder cart		12	29		-	-	1 per each section

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			To procure 24 pulse oximeters per hospital		24	29	90,000	62,640,000	27,235	2 per each section
			To procure 66 vital sign monitors per hospital		66	29	850,000	1,626,900,000	707,348	ICU 10, EMD 10, OT 6, NICU 40
5	Specialized Hospitals	To equip Specialized Hospital level health facilities in all levels with oxygen delivery and monitoring equipment	To procure 106 wall mounted flow meters		116	6	160,000	111,360,000	48,417	ICU 24, EMD 16, OT 6, NICU 40, WARDS 36,Assumption is all mentioned beds in respective ward/section will have a patient who is in need of oxygen at per each day
			To procure 12 flowmeter & regulators(for transport)		12	6	160,000	11,520,000	5,009	At least 1 flow meter per 12 service area
			To procure 1500 Nasal prone cannula per month		18000	6	3,000	324,000,000	140,870	50 patients will receive oxygen through nasal prongs per day
			To procure 1350 Nonrebreather per month		16200	6	7,500	729,000,000	316,957	45 pts (1/3 who needs oxygen) expected to use non rebreather face mask per day
			To procure 1500 simple facemask per month		18000	6	3,500	378,000,000	164,348	50 patients will receive oxygen through simple face mask per day
			To procure 12 cylinder valve key/spanner per hospital		12	6	20,000	1,440,000	626	At least 1 cylinder valve key per each service area
			To procure 12 flow meter spanners		12	6	20,000	1,440,000	626	At least 1 flow meter spanner per each section
			To procure 12 cylinder cart		12	6		-	-	
			To procure 24 pulse oximeters per hospital		24	6	90,000	12,960,000	5,635	Assumption 2 pulse oximeters per each section
			To procure 66 vital sign monitors per hospital		66	6	850,000	336,600,000	146,348	Assumptions in ICU 10 monitors, EMD 10, OT 6, NICU 40
6	Zonal and National Referral Hospital	To equip Zonal referral and National Hospital level health facilities in all levels with oxygen delivery and monitoring equipment	To procure 70 pulse oximeters per Hospital		70	9	90,000	56,700,000	24,652	
			To procure 360 Wall mounted Flowmeters per hospital		240	9	160,000	345,600,000	150,261	
			To procure 1000 Nasal Cannula per month per hospital		1200	9	3,000	32,400,000	14,087	
			To procure 500 Non-rebreather mask per month per hospital (adult)		6000	9	7,500	405,000,000	176,087	
			To procure 500 Non-rebreather mask per month per hospital (pediatrics)		1200	9	7,500	81,000,000	35,217	
			To procure 500 simple Face Mask per month per hospital (adult)		6000	9	3,500	189,000,000	82,174	

Costed Interventions of National Medical Oxygen Scale-up Plan (2022 - 2027)										
No.	**Activities description**	**Sub-activities**	**Activity Description/Details**	**Unit**	**Quantities**	**Unit Cost**	**Frequency/Days**	**Amount (TZS)**	**AMOUNT (USD)**	**Assumptions**
			To procure 500 simple Face Mask per month per hospital (pediatrics)		3600	9	3,500	113,400,000	49,304	
			To procure 50 flowmeter & regulators(for transportation)		50	9	160,000	72,000,000	31,304	
			To procure 40 Cylinder valve spanners per hospital		20	9	20,000	3,600,000	1,565	
			To procure 40 Flowmeter spanner per hospital		20	9	20,000	3,600,000	1,565	
			To procure 40 Cylinder carts per hospital		30	8	100,000	24,000,000	10,435	
			To procure 300 patient's monitors per hospital		120	8	850,000	816,000,000	354,783	
SUB TOTAL								**125,800,055,000**	54,695,676	
GRAND TOTAL								**986,616,129,000**	**428,963,534**	