

**183. PROFILE ON MEDICAL EQUIPMENTS
MAINTENANCE AND OPERATION
TRAINING SERVICE**

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I. SUMMARY

This profile envisages the establishment of medical equipments maintenance and operation training service center with a capacity of providing repair and maintenance for 3,491 assorted medical equipment and training for 230 persons per annum.

The market study shows that at present 32,912 assorted medical equipments require repair and maintenance service annually which will increase to 45,355 assorted medical equipments by the year 2018.

The total investment requirement is estimated at about Birr 3.28 million, out of which Birr 2 million is required for equipment. The service will create employment opportunities for 61 persons.

The project is financially viable with an internal rate of return (IRR) of 18.09 % and a net present value (NPV) of Birr 1.39 million, discounted at 8.5%.

II. SERVICE DESCRIPTION & APPLICATION

The maintenance of medical equipment requires a wide range of technical abilities, and the costs and time required to train a technician increase markedly with the level of skill that has to be attained. Experience in many developing countries has revealed that training of technicians to a high level of skills is very expensive.

Therefore, the approach for the training of technicians, to do front-line maintenance, for medical equipment in health facilities requires less time, costs, and delivers benefits to a larger population, supporting primary health care, by servicing large volume of essential medical equipment in widely distributed health facilities in the capital city and other parts of regional administrations.

Medical equipment maintenance and operation training service, therefore, includes provision of services like training, maintenance and repair of medical equipment, focusing on building sustainable technical capacity, implementing transparent & pragmatic systems, while focusing on the preventative care and safe usage of medical equipment.

III. MARKET STUDY AND SERVICE CAPACITY

A. MARKET STUDY

1. Service Supply and Present Demand

There are two aspects to the services supply surrounding medical equipment usage and handling. In countries with highly systematized and diversified health care services provision, this service is known as ‘Bio-med Engineering;’ and consists in standardization of diagnostic and therapeutic equipment, installation of equipment and apparatus, carrying out preventive and corrective maintenance on equipment, provision of in-service, hands-on-training to equipment operators, and investigate device related incidents. In short, for countries like Ethiopia, the service is the integration of foreign expertise and technology with local human resources.

Apart from trainings provided at Radiology Departments of medical faculties of universities, no worthwhile training is provided regarding medical equipment operations at medium level. The minimal trainings provided to laboratory, X-ray or Ultra sonic equipment and apparatus operating technicians do not go beyond rudimentary operational procedures. These equipment are designed with strict safety standards; and in the event of a malfunction, the operators are lost on how to proceed.

There are at present close to 145 drugs suppliers and medical equipment importers and distributors. Tens of millions of Birr worth of medical equipment and apparatus are being imported every year.

Disregarding heavy and very expensive equipment like CAT Scans for a moment, a sample of 6 types of diagnostic and monitoring apparatus imported from 2003 to 2006 is believed to provide an insight into the supply and demand for medical equipment maintenance and operations training services (see Table 3.1, 3.2).

Table 3.1
IMPORT OF MEDICAL EQUIPMENT AND APPARATUS

Year	Ultraviolet/Infrared Apparatus (Kg)	Ultra Sonic Scanning Apparatus (Kg)	Electro Cardiograph (UN)
2003	1,153	6,075	1,265
2004	538	14,510	3,906
2005	11,572	1,202	1,323
2006	26,592	2,874	8,295
Total	39,855	24,661	14,789
Average	9,963	3,697	6,165
Total Value	8,264,460	13,634,503	4,044,412

Source: Ethiopian Customs Authority annual external trade statistics, unpublished.

In the 4-year period from 2003 to 2006, Birr 25,943,375.00 or annual average of Birr 6,485,843.75 was spent for the importation of the three types of medical equipment and apparatus alone. The importation regularly of such large quantities was necessitated probably due to the absence of any maintenance services provider for such equipment.

The other medical equipment types consist in:

- Apparatus of Alpha, Beta or Gamma radiations for medical uses
- Apparatus based on use of X-rays for medical, surgical veterinary uses, including dental use and
- Apparatus based on X-Rays

Import and corresponding value of these heavy equipments and apparatus is presented in Table 3.2.

Table 3.2

**IMPORT of X-RAY, GAMMA-RAY EQUIPMENT FOR MEDICAL, SURGICAL,
OTHER USES: {UN}**

Year	Apparatus of Alpha, Beta Or Gamma Radiations For Medical Use (Including X-Ray Tubes		Apparatus Based on Use of X-Rays For Medical, Surgical & Veterinary Uses; (Including For Dental Use)[Units]		Apparatus Based on Use Of X-Rays, Nes	
	Quantity	Value	Quantity	Value	Quantity	Value
2003	15,786	5,707,852	1,435	11,875,671	1,440	4,741,466
2004	27,136	5,299,515	1,685	4,894,007	532	9,210,833
2005	205	1,236,162	128	21,511,712	29	3,739,304
2006	12,782	21,098,642	288	7,496,916	2,849	18,705,404
Total	55,909	33,340,171	3,536	45,778,306	4,850	36,397,007
Average	13,977		884		1,213	

Source: Ethiopian Customs Authority annual external trade statistics, unpublished

In the 4-year period from 2003 to 2006, Birr 115,515,484.00 or annual average of Birr 28,878,871.00 was spent for the importation of the three types of medical equipment and apparatus listed immediately above.

The data presented in Tables 3.1 and 3.2 is for equipment and apparatus of assorted sizes and dimensions. Both heavy, and small and light equipment and apparatus are often lumped together. Some outlier figures have been deducted from the import data as a consequence. Experts in the ‘Bio-med engineering’ profession are of the opinion that most of these items with outlier figures could be “use-and-throw” material.

Tables 3.1 and 3.2 were presented to demonstrate two things:

- a) The volume of foreign exchange incurred every year for their importation; and

- b) That most of these items may have been imported repeatedly as replacement for malfunctioning equipment and apparatus, which due to the absence of maintenance services providers were being cast away.

The supply of a specialized preventive and corrective maintenance services provider is almost non-existing. Whatever in-service training programs and courses were given during periodic and brief workshops were organized by visiting expatriates. There is no denying that there are rare cases where individuals with good grasp of radio technology undertake rudimentary repair work on ECG and Gastro scope equipment.

In determining present demand for maintenance and operation training services, certain valid assumptions must be forwarded and computations done in connection with data in Tables 3.1 and 3.2.

- 25% of the import classified under Ultra Violet/Infrared apparatus are repairable and weigh 40kg.
- 75% of Ultra Sonic Scanning apparatus are repairable and that each weighs 40 kilograms
- All ECG are repairable and that All of the equipment and apparatus under X-ray and Gamma ray classification are also repairable
- 75% of Alpha, Beta and Gamma radiations are repairable; the X-ray tubes are replaceable.
- Quantity to the rate of twice the average annual import of apparatus and equipment, in other words, the average import in the last two years, are still operational.

Accordingly, the equipment and apparatus requiring maintenance work, i.e. present demand for medical equipment maintenance is shown in Table 3.3.

Table 3.3
MEDICAL EQUIPMENT AND APPARATUS REQUIRING MAINTENANCE
SERVICES

Equipment/Apparatus	Average Import	At 25%	At 75%	At 40kg Per Unit (No)	Present Service Demand: (Average 2-Years Import)
UV & Infra red	9,963	2,491	-----	63	126
Ultra sonic Scanning	6,165	----	4,624	116	232
ECG	3,697	----	----	----	7,394
Apparatus of Alpha, Beta, Gamma ray	13,977	---	10,483	----	20,966
Apparatus based on X-ray for medical, surgical	884	---	---	----	1,768
Apparatus based on X-ray	1,213	---	---	----	2,426

Note: Derived from Table 3.1 and 3.2.

2. Projected Demand

Future demand increase is based on the forecasted increase in medical health services facilities for the coming 10 years which is 3.0% per annum. Based on this rate, the projected demand for medical equipment maintenance and operations training service is presented in Table 3.4.

Table 3.4
PROJECTED DEMAND FOR MEDICAL EQUIPMENT MAINTENANCE
SERVICES

Year	UV & Infrared Apparatus	Ultra Sonic	ECG	Apparatus for Alpha, Beta, Gamma Radiations	Apparatus Based on X-Ray for Medical...	Apparatus Based on X-Ray
2009	130	239	7,616	21,594	1,821	2,499
2010	134	246	7,844	22,242	1,876	2,574
2011	138	253	9,079	22,909	1,932	2,651
2012	142	261	9,322	23,597	1,990	2,730
2013	146	269	9,571	24,305	2,049	2,812
2014	150	277	9,829	25,034	2,111	2,897
2015	155	285	10,124	25,785	2,174	2,984
2016	160	294	10,427	26,558	2,240	3,073
2017	164	303	10,740	27,355	2,304	3,165
2018	169	312	11,062	28,176	2,376	3,260

3. Pricing And Service Provision

The equipment installation and maintenance services are not only delicate electronic apparatus, but some also expose one to radioactivity.

A charge of 5% of the original value of the equipment for scheduled preventive services; and 20% of the original value of the equipment for installation, commissioning and operation training services for technicians who handle the equipment is recommended.

Service is provided in three ways.

- a) Package services provision consisting of installation, trial run and operational training is carried out within the premises of the client.

- b) Scheduled preventive maintenance is also carried out at the clients' place of work.
- c) Corrective maintenance is to be carried out at the service providers repair shop. Repair work on big and heavy equipment should be carried out at the clients.

However, for the purpose of financial analyses Birr 500 per service and repair of a medical equipment and Birr 5,000 per head for training is adopted.

B. CAPACITY AND SERVICE PROGRAMME

1. Capacity

Taking in to account the market study on existing condition of medical equipment maintenance and operation training service, and based on the projected demand of the service and the economic level of service provision, the envisaged service center will provide:

- Full-fledged consultancy services from concept to commissioning,
- Training on equipment operation,
- Repair and maintenance training, and
- After -sales services.

The annual capacity of the envisaged center to provide the stated services is shown on Table 3.5.

Table 3.5
ANNUAL SERVICE CAPACITY

Sr. No.	Type of Medical Equipment	Assorted Type and Sizes of Medical Equipment [Lump Sum]	Number of Bio- Medical Technicians Trainees
1	UV & Infrared Apparatus	13	10
2	Ultra Sonic	24	15
3	Electrocardiograph (ECG)	762	20
4	Apparatus for Alpha, Beta, Gamma Radiations	2,160	25
5	Apparatus Based on X-Ray for Medical centers	182	30
6	Apparatus Based on X-Ray	250	40
7	Laboratory Equipment	100	90
	Total	3491	230

The service will be given for one shift of eight hours per day.

2. Service Programme

The project requires some years to penetrate into the market and capture a significant share. It will start providing services at 75% and 90% of its rated capacity in the first and second year of service provision, respectively. Full service provision shall be attained in the third year and then after.

The proposed service provision program is shown in Table 3.6.

Table 3.7**SERVICE PROVISION PROGRAMME**

Sr. No.	Service	Service Year		
		1	2	3- 10
1	Service provision rate (%)	75	90	100
2	Equipment maintenance (assorted)	2618	3142	3491
3	Operation training (No)	173	207	230

IV. MATERIALS AND INPUTS**A. MATERIALS**

The main materials and inputs required for the provision of medical equipment maintenance and operation-training services are indicated in Table 4.1. The costs of these materials are estimated to be of Birr 800,000 while the center reaches at its full capacity.

Table 4.1
ANNUAL MATERIAL AND CONSUMABLE
REQUIREMENT AT FULL SERVICE CAPACITY

Sr. No.	Description	Unit of Measure	Qty	Cost (000) Birr
1	Design and publication of Training manuals,	-	Lump sum	350.00
2	Text Books, (Assorted types)	-	Lump sum	100.00
3	Audio visual training kits,	-	Lump sum	182.00
4	Stationery materials,		Lump sum	70.00
5	Lubricating oils,	Lt.	250	2.50
6	Chemicals, (Assorted types)		Lump sum	50.00
7	Soldering leads,	Kg	50	3.50
8	Insulating taps, Assorted	Roll	300	1
9	Electronic components, and parts, Assorted		Lump sum	100.00
10	Dry cell, assorted	Pck	20	2.00
11	Alkaline batteries, Lump sum	Pct	20	3.50
12	Welding electrodes	Pct	100	15.00
13	Carbides	Kg	300	6.00
14	Bottled Oxygen	Kg	500	10.00
15	Refrigerant	Kg	144	4.50
16	Other miscellaneous items			250.00
	Total			800.00

B. UTILITIES

The major utilities required by the center are electricity, diesel oil and water. The estimated annual requirement at full capacity and the corresponding cost is given in Table 4.2.

Table 4.2**ANNUAL UTILITIES REQUIREMENT AND ESTIMATED COST**

Sr. No.	Description	Unit of Measure	Qty.	Unit Price (Birr)	Cost ('000 Birr)
1	Electricity	kWh	60,000	0.4736	28.416
2	Fuel oil (stand by diesel generator)	lt	1000	6.90	6.90
3	Water	m ³	1000	3.25	3.25
	Total				38.566

V. TECHNOLOGY AND ENGINEERING**A. TECHNOLOGY****1. Service Process**

The medical equipment maintenance and operation training services are rendered to various hospitals, clinics, diagnostic laboratories, bio medical research centers and other related institutions utilizing medical equipment. The services are provided both at the service center and at the client's site, as required.

The service provision is basically categorized as follows:

a) Full-fledged and packaged consultancy service:

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

- Based on the specifications and the standards set out by concerned governmental bodies, the envisaged center will participate on the pre and post tendering activities.
- Acquisition and translation of manuals and other vital medical documents / materials;
- Developing and implementing procedures and rules designed to better care for the medical equipment, create accountability, clarity and transparency in the care and usage of medical equipment; implement a plan to prevent unauthorized repair and usage.
- Installation, testing and commissioning:
 - Handling of erection or erection supervision activities (Installation, testing, commissioning and operation, and safety training), as required.

b) Maintenance contract for scheduled and unscheduled maintenance

- Comprehensive inventory including:
 - Development of detailed historical maintenance records which show history, current status, location, responsible staff member for oversight, scheduled (Preventive) maintenance needs, online and updated supplier contact information, etc.
- Proper cleaning, calibration and other regular scheduled maintenance work;
- Critical / emergency equipment response program (on-call service including emergency response procedures);
- Equipment repair; if an extremely specialized and sophisticated piece of equipment, if cannot be handled by and local technicians.
- Quality assurance / quality control plan customized for a hospital or clinic;
- Work order system: request which will be acted upon in under 24 hours including an urgency criteria; etc

c) **Training:**

In addition to the above-mentioned services, the envisaged center will also provide a general biomedical maintenance technician training for the assorted types and sizes of medical equipment under consideration. The minimum requirement of entry level is grade 10 of vocational students for regular training sessions of 10+1, 10+2 and 10+3 programs. Up-grading and tailor-made sessions will also be provided to various institutions upon special request.

The training course generally consists of lectures and practical sessions on the following topics:

- **Medical equipment management:** including all aspects of an equipment life cycle. Use material in this guide. Emphasize equipment inventory lists and equipment service history record keeping. The basic concepts of quality management can also be included: goal setting, incremental steps but persistent and continuing improvements.
- **Human Physiology and Anatomy**
- **Healthcare Technology Management**
- **English:** includes oral and reading skills, grammar, vocabulary, technical English, letter and report writing
- **Mathematics:** includes computation, logarithms, trigonometry, basic algebraic equations, and graphical representation.
- **Technical drawing:** includes use of technical drawing instruments, elementary construction, pictorial projection, sections, electrical drawing, and visualization.
- **Workshop:** includes electrical installations, theory and practice of domestic and industrial wiring, selection of cables, lighting circuits, earthing systems, types of lamps, principles and practice of arc welding, gas welding, sheet-metal welding, plumbing, bench fitting, use of files, hacksaws, chisels, drills and drilling, threads, piping systems, workshop maintenance.
- **Electronics and electro-technics:** includes electrical instruments, DC and AC circuitry, electrical components, transformers, AC and DC motors, semiconductors, power supplies, amplifiers, applications of thyristors,

DIACs and TRIACs.

- **Mechanical services (hospital plant):** includes heating and hot water services, refrigeration, ventilation and air-conditioning, lubricants, stand-by generators, test vehicle repair and servicing.
- **Medical Equipment:** includes principles, operation and simple repairs and maintenance of: UV & Infrared Apparatus, Ultra Sonic, Electrocardiograph (ECG) ,Apparatus for Alpha, Beta, Gamma Radiations, Apparatus Based on X-Ray for Medical, Apparatus Based on X-Ray and Laboratory Equipment like blood pressure meters, stethoscopes, water baths, microscopes, autoclaves, sterilizers, trolleys, basic mechanical equipment, suction machines, centrifuges, theatre lights and lamps
- **Hospital fieldwork:** work in hospital workshops under supervision, involving repair and maintenance.
- **Some opportunities for further training:**

During the purchase of new equipment suppliers can be requested to train in-house technicians in maintenance, often at no cost. This condition should be included in the call for tender or purchase order. Because equipment suppliers are obliged to provide comprehensive warranty and maintenance services, it may be quite expensive for them to establish a local service staff. They may be quite willing to train in-house technicians.

Major health development projects frequently include large volumes of equipment procurement. This provides excellent opportunities for maintenance training and for obtaining current equipment for training. Planning officials should be approached to include such requirements in the procurement agreements:

1. Comprehensive operation and maintenance training to in-house staff or local trainers; and
2. An extra set of major equipment should be purchased for the training workshops.

This way, the most relevant training can be given. In bilateral aid programs, donor countries often provide modern health facilities and sophisticated equipment to

developing countries like Ethiopia. This is an excellent opportunity to request advanced technical and medical equipment management training for in-house staff.

District workshops can request teaching from technicians in national hospitals that in-house technicians can also learn from external companies while monitoring their services.

The provision of such services doesn't have any adverse impact on environment.

B. ENGINEERING

1. Machinery and Equipment

The list of machinery, equipment and other facilities required for provision of the medical equipment maintenance and operation training services is estimated to be Birr 2,000,000, out of which Birr 1,000,000 is required in foreign currency (see Table 5.1).

Table 5.1**MACHINERY, EQUIPMENT & TOOLS REQUIREMENT AND COST**

Sr. No.	Description	UOM	Qty.	Cost ('000 Birr)
1	Broadband internet line (Supply & Network Installation)	Unit	1	220.00
2	Laboratory Equipment, assorted	Lot	2	245.00
3	Mechanical work bench with vice	Set	10	30.00
4	Electrical/electronic work bench with regulated AC and DC power supply outlets	Set	10	200.00
5	Vacuum cleaners and accessories (Assorted)	Set	5	50.00
6	Mobile diesel generator with canopy attachment and control system 11KW	Set	1	20.00
7	Mobile grinding machine with accessories (Assorted)	Set	10	30.00
8	Mobile drilling machine with accessories (Assorted)	Set	10	35.00
	Mobile arc welding transformer	Set	4	100.00
9	Mobile gas welding machine	Set	4	60.00
10	Mechanic tool kit with metallic box	Set	10	30.00
11	Electrical/electronic measuring instruments (Assorted)	Set	10	35.00
12	TV-set	Set	2	10.00
13	Retractable aluminum ladder (12 mt)	Pcs	20	60.00
14	Technical drawing kit	Lot	20	20.00
15	Plumber tool kit with metallic box	Set	10	20.00
16	Refrigerator maintenance and repair kit	Set	2	70.00
17	Soldering gun	Set	15	60.00
18	Lead sucker	Pcs	15	3.00
19	DVD player	Set	2	2.00
20	Cafeteria facilities	Set	1	100.00
21	Used medical equipment, assorted types and size (For teaching purpose)	Lump sum		200.00
22	Other miscellaneous items			400.00
	Total			2,000.00

2. Land, Building and Civil Works

The envisaged medical equipment maintenance and operation training center requires a area is the indoor built -up area of 500 m² for administration offices, reception, maintenance workshops, class rooms, tools and instrument store, toilet, etc.

It is assumed that the envisaged project will rent the required space. Accordingly, at the rate of Birr 50 per m² / month the annual rental cost is estimated at Birr 300,000.

VI. MANPOWER AND TRAINING REQUIREMENT

A. MANPOWER REQUIREMENT

1

The total manpower requirement, including skilled and unskilled labor is 61 persons. The corresponding total labor cost, including fringe benefits, is estimate at Birr 1,025,250 Table 6.1 shows the list of manpower required and the estimated annual labour costs.

Table 6.1
MANPOWER REQUIREMENT & LABROUR COST

Sr. No.	Description	Req. No.	Salary (Birr)	
			Monthly	Annual
1.	General manager	1	4,000	48,000
2.	Snr. Secretary	1	1,000	12,000
3.	Head, finance & administration	1	3,500	42,000
4.	Instructors	10	30,000	360,000
5.	Snr. Medical equipment expert	1	3,500	42,000
	Documentation attendant	1	900	10,800
6.	Financial clerk	1	800	9,600
7.	Secretaries	3	2,250	27,000
8.	Snr Technician	10	650	7,800
9.	Jnr. Technician	10	10,000	120,000
10.	Driver	2	1,200	14,400
11.	Cashers	2	1,400	16,800
12.	Cleaners	6	3,000	36,000
13.	Store keeper	2	1,200	14,400
14.	Guard	7	3,850	46,200
15.	Cafeteria Attendant	2	700	8,400
16.	Gardener	1	400	4,800
	Sub-Total	61	68,350	820,200
	Workers benefit (25% of BS)	-	17,087.5	205,050.00
	Total	61	85,437.5	1,025,250

B. TRAINING REQUIREMENT

Instructors and Technicians need to get local tailor made training and attachment training at similar centers. The cost of training is estimated at Birr 200,000 out of which 100,000 is in foreign currency.

VII. FINANCIAL ANALYSIS

The financial analysis of the medical equipments maintenance and operation training project is based on the data presented in the previous chapters and the following assumptions:-

Source of finance	30 % equity
	70 % loan
Bank interest	8.5 %
Discount cash flow	8.5%
Accounts receivable	30 days
Raw material local	30 days
Raw material, import	90 days
Cash in hand	5 days
Accounts payable	30 days
Repair and maintenance	5% of machinery cost

A. TOTAL INITIAL INVESTMENT COST

The total investment cost of the project including working capital is estimated at Birr 3.28 million, of which 33% is required in foreign currency. The major breakdown of the total initial investment cost is shown in Table 7.1.

Table 7.1
INITIAL INVESTMENT COST ('000 Birr)

Sr. No.	Cost Items	Local Cost	Foreign Cost	Total Cost
1	Land lease value	-	-	-
2	Building and Civil Work	-	-	-
3	Equipment	1,000.0	1000.0	2,000.00
4	Office Furniture and Equipment	75.00	-	75.00
5	Vehicle	450.00	-	450.00
6	Pre-production Expenditure*	431.61	100.0	531.61
7	Working Capital	230.24	-	230.24
	Total Investment cost	2,186.85	1,100.0	3,286.85

* *N.B Pre-production expenditure includes interest during grace period (Birr 231.61 thousand), training (Birr 200 thousand) and Birr 50 thousand costs of registration, licensing and formation of the company including legal fees, commissioning expenses, etc.*

B. OPERATION COST

The annual production cost at full operation capacity is estimated at Birr 2.77 million (see Table 7.2). The material cost accounts for 28.82 percent of the operation cost. The other major components of the operation cost are direct labour, depreciation and administration cost which account for 17.73%, 13.24% and 11.82%, respectively. The remaining 28.40 % is the share of labour overhead, utility, repair and maintenance, working premise rental and financial cost.

Table 7.2**ANNUAL OPERATING COST AT FULL CAPACITY ('000 BIRR)**

Items	Cost	%
Raw Material and Inputs	800.00	28.82
Utilities	38.57	1.39
Maintenance and repair	100.00	3.60
Labour direct	492.12	17.73
Labour overheads	205.05	7.39
Administration Costs	328.08	11.82
Working premise rental	300.00	10.81
Total Operating Costs	2,263.82	81.54
Depreciation	367.50	13.24
Cost of Finance	144.89	5.22
Total Production Cost	2,776.21	100

C. FINANCIAL EVALUATION**1. Profitability**

Based on the projected profit and loss statement, the project will generate a profit through out its operation life. Annual net profit after tax will grow from Birr 165.50 thousand to Birr 494.54 thousand during the life of the project. Moreover, at the end of the project life the accumulated cash flow amounts to Birr 3.26 million.

2. Ratios

In financial analysis financial ratios and efficiency ratios are used as an index or yardstick for evaluating the financial position of a firm. It is also an indicator for the strength and weakness of the firm or a project. Using the year-end balance sheet figures and other relevant data, the most important ratios such as return on sales which is computed by dividing net income by revenue, return on assets (operating income divided by assets),

return on equity (net profit divided by equity) and return on total investment (net profit plus interest divided by total investment) has been carried out over the period of the project life and all the results are found to be satisfactory.

3. Break-even Analysis

The break-even analysis establishes a relationship between operation costs and revenues. It indicates the level at which costs and revenue are in equilibrium. To this end, the break-even point of the project including cost of finance when it starts to operate at full capacity (year 3) is estimated by using income statement projection.

$$\text{BE} = \frac{\text{Fixed Cost}}{\text{Sales} - \text{Variable Cost}} = 60 \%$$

4. Payback Period

The pay back period, also called pay – off period is defined as the period required to recover the original investment outlay through the accumulated net cash flows earned by the project. Accordingly, based on the projected cash flow it is estimated that the project's initial investment will be fully recovered within 5 years.

5. Internal Rate of Return

The internal rate of return (IRR) is the annualized effective compounded return rate that can be earned on the invested capital, i.e., the yield on the investment. Put another way, the internal rate of return for an investment is the discount rate that makes the net present value of the investment's income stream total to zero. It is an indicator of the efficiency or quality of an investment. A project is a good investment proposition if its IRR is greater than the rate of return that could be earned by alternate investments or putting the money in a bank account. Accordingly, the IRR of this project is computed to be 18.09 % indicating the viability of the project.

6. Net Present Value

Net present value (NPV) is defined as the total present (discounted) value of a time series of cash flows. NPV aggregates cash flows that occur during different periods of time during the life of a project into a common measuring unit i.e. present value. It is a standard method for using the time value of money to appraise long-term projects. NPV is an indicator of how much value an investment or project adds to the capital invested. In principle a project is accepted if the NPV is non-negative.

Accordingly, the net present value of the project at 8.5% discount rate is found to be Birr 1.39 million which is acceptable.

D. ECONOMIC BENEFITS

The project can create employment for 61 persons. The project will generate Birr 841.11 thousand in terms of tax revenue. The maintenance and operation training centre will support the health sector of the city by servicing large volume of essential medical equipments.