

## Study of 3-Tesla Mri Unit At A Tertiary Care Teaching Hospital With Special Emphasis On Physical Facilities, Work Flow And Break-Even Analysis.

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### I. Introduction

Twentieth Century has witnessed exceptional advances in technology which has brought scientific marvels into hospitals with unprecedented demand on medical services, particularly in areas such as surgery, clinical laboratory and radiological services<sup>1</sup>. While the physicians have in recent years acknowledged the desirability of providing more cost-effective medical care, this theoretical goal is infrequently attained in practice due to absence of adequate financial data in respect of alternative diagnostic and therapeutic strategies<sup>2</sup>. In an era of limited resources and unlimited demand for health care, health economists tend to weigh benefit against cost when making informed choices. Those responsible for allocating resources will need to prioritize between competing claims so that maximum benefit can be obtained from a given budget.<sup>3</sup> Naikwadi (2015) reiterated the health care diagnostic segment is growing rapidly, creating a major market for manufacturing of medical equipment and devices in India. The theoretical advantages of the high field are<sup>4</sup> the improvement of the signal over noise ratio, an increase in the diffusion effect. In a competitive market and increasing budget deficits of governments, health service organizations expose to the challenge of cost containment strategies in general and measuring their costs in particular (5, 6). Unit-cost of health services is the cornerstone of privatization policies, tariff setting, financial management, and health economic studies (7) The diagnostic market is the fastest growing segment in India, with forecasted to grow to US \$17 billion by 2021 according to Price water house Coopers (PwC). The most important and effective managerial tool is Break even analysis (BEA), also called as cost- Volume Profit Analysis (CVPA). It is an important analytical technique used to study relations among expenses, revenue and profits. When considering the purchase of new diagnostic equipment, the HCM behave to estimate the BEA or Break-Even Point (BEP), by this the HCM can determine approximately how long, based on the current amount of services in HCO, it will take to recoup the expenses of a given expenditure. The estimation of BEP is also useful in assessing the established diagnostic facility in HCO.

### AIM

To study the MRI 3-TESLA unit at Nizam's Institute of Medical Sciences with special emphasis on physical facilities, work flow and break-even analysis.

### II. Methodology:

The study was a biphasic study consisting of retrospective and prospective study. The retrospective study was a record study done period of 3 months whereas the prospective study was record study, observational study, interviewing method and reviewing of material having a bearing on the study done for a period of 1 month.

Both studies consists of record study from the following sources.

- Academic section, human resources department and claims department in assessing the expenditure incurred in terms of salaries paid to staff working in MRI 3-TESLA.
- Planning section, Finance department in calculating the expenditure on equipment in MRI 3-TESLA.

- c) Civil Engineering department, Electrical Engineering department, Biomedical Engineering department, NIMS laundry, NIMS laboratory stores, nursing stores for assessing the maintenance costs/overheads.

Literature review of procedures and protocols of radiology lab was reviewed.

Radiology department and MRI 3 –TESLA of Nizam’s Institute of Medical Sciences was visited and the requisite data collected. Personal interviews were conducted with staff of these areas. People interviewed were included Doctors, MRI Technicians, nurses, &staff. To study the physical facilities and work flow of the MRI, direct observational study was conducted.

### III. Results And Discussion

The MRI 3-tesla unit in Nizam’s Institute of Medical Sciences is situated in the 2nd floor of the Emergency building (PMMSY). Total built up area of MRI 3-TESLA is 51.2sq.mtr / 551.1122 sq.feet. There is a waiting lounge for patients and their attenders provided with three seater chairs for 30 patients. Patient holding area i.e. pre-post op observation room where patients are kept. before taking to procedure room for the final preparation of the patient and after the procedure patient is kept under observation if necessary. This room has nurses station for administrative work of the staff. It is equipped with two trolleys, two wheel chairs and one oxygen manifold. Console room is attached to a patient holding and is provided with split AC. Equipment room, which consists of MRI equipment. Reporting room adjacent to console room which consists of 5 X-ray screens. Report typing room consists of two computers for typing the reports screened by the doctors. Reception area consists of records for scheduling the appointments and reports will be disclosed here.

#### AIR CONDITIONING:

Each procedure room is provided with a 7.5 TR ductable split air conditioning system and the remaining area of MRI 3-TESLA is provided with 35TR of Centralized A/C. Each console room is provided with a 2 TR split A/C.

Total load of the MRI 3-TESLA lab is 15 TR+35 TR+ 4 TR=54 TR.

#### UNINTERRUPTED POWER SUPPLY:

Uninterrupted power supply is provided by the 120KVA UPS located in the UPS room of the MRI 3-TESLA suite.

#### EQUIPMENT:

MAGNETOM® Skyra is the world’s first 3 Tesla, 70 cm Open Bore Tim+Dot system. MAGNETOM Skyra also has low operational costs and is easy to site. As the shortest 3T system on the market today, it fits into the footprint of most conventional 1.5T systems. The Zero Helium boil-off technology, the system does not use any helium during normal operation, so this expensive and scarce resource does not need regular refill intervals. Additionally, with the new Green Cooling Package (option), customers can decrease their energy consumption for cooling by up to 50%\*.

#### STAFFING:

MRI 3-TESLA services are provided on 24\*7 basis for the convenience of the patients. The details of staff posted at MRI is depicted in the following table:

**Table 1: STAFF OF MRI 3 TESLA**

Sl No.	Designation	Number of Staff
1	Professor	1
2	Associate Professor	1
3	Resident Doctors	4
4	Nurses	2
5	Technicians	5
6	Record Assistants	4
7	Class IV Employess	3

#### WORK LOAD:

**TABLE 2 : Total number of scans month wise**

SLNo.	Month	No. of Investigations
1	April 2019	859
2	May 2019	880
3	June 2019	852

<b>TOTAL</b>	<b>2491</b>
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Average daily cases = 28.

**TABLE 3: COST CENTRES ASSOCIATED WITH MRI**

SI No	COST CENTRE	COST CATEGORY	COST TYPE
1	Salaries of staff	Direct cost	Fixed
2	Material	Direct cost	Variable
3	Equipment	Direct cost	Fixed
4	Building	Indirect cost	Fixed
5	Air Conditioning	Indirect cost	Fixed
6	Electricity	Indirect cost	Variable
7	Laundry	Indirect cost	Variable
8	Linen	Indirect cost	Fixed
9	Water	Indirect cost	Variable

Man power post for three months (study period) = Rs.53,18,319/-

**MATERIAL COST:**

Direct Material cost of the MRI scan includes: Contrast agents & Anaesthesia  
The cost for 3 months incurred where Rs.9662/-

Indirect Material cost of the MRI scan includes films, stationary, requisition forms, injections, report printing paper, log books, covers.

The cost details from the month of april-2019 to june-2019 is Rs.5,03,539/-

**EQUIPMENT COST:**

As per the information from the records of planning department MRI equipment is purchased for a sum of Rs 13,70,90,000/- in the year 2016 and installed in the month of March 2017. The equipment is under warranty for a period of 3 years. The life of equipment is taken as 9 years as per the advise of the Biomedical engineering department of the NIMS. Hence, the depreciation amount was calculated by using sum of the years digits depreciation method of the equipment value which amounts for Rs 68,54,500/-

**BUILDING COST:**

Building cost was determined under three heads

- Construction cost
- Maintenance cost and

**1. CONSTRUCTION COST:**

As per the CPWD cost index April 2015 with 01/10/12 (as base 100) issued by the director general(DG) CPWD is 104. The building cost for 1 sqm area calculated after incorporating this cost index and after discussion with the civil engineering department was Rs 37,465./- Taking the life of building as 100 years ,depreciation is calculated as 1% of the capital cost. For area of 51.2 sqm, construction cost is Rs 19,18,208/- . Depreciation cost is Rs .47,955/- for 3 months

**2. MAINTENANCE COST:**

As per CPWD manual, cost of maintenance persq.mt is Rs 5104/- per year which amounts to Rs **65,331/-**

**Total building cost for 3 months = construction cost + maintenance cost**  
**= Rs.8256 + Rs.65331**  
**= Rs.73587/-**

**AIRCONDITIONING COST:**

**i) INSTALLATION COST OF AC:**

Load of MRI Suite in the central A.C plant is 35TR.

- a) By this information ,installation cost for MRI area(i.e. 35 TR load) is Rs 10,50,000.
- b) Installation cost of ductable split AC in procedure rooms is Rs 9,00,000/-
- c) Installation cost of Two 2TR split AC in reporting rooms is Rs 80,000/-

**TOTAL INSTALLATION COST OF AC IN MRI = a+b+c = Rs.20,30,000/-.**

Assuming life of the air conditioning system as 10 years depreciation rate is taken as 10%,

**TOTAL INSTALLATION COST OF AC IN MRI = a+b+c = Rs.20,30,000/-.**

**ii) MAINTENANCE COST OF AC:**

Calculated maintenance cost central AC of MRI area is equal to Rs 52,000/- per annum. Two split air conditioners and ductable split air conditioners are under warranty. So there is no maintenance charges for them.

**COST OF ELECTRICITY**

With the help of electrical engineer total electricity consumed in a day is calculated and the cost incurred is calculated @ Rs 8.5 per unit of the electricity.

Estimated power consumption is equal to 3340.48 KWH per day which is equivalent to amount Rs 28394.08/- at unit price @Rs 8.5/-

Estimated Cost incurred per month on electricity of the MRI =Rs 8,51,820 /-

**Cost incurred on electricity for three months = 25,55,460/-**

**7) COST OF LINEN AND BEDSHEETS:**

The linen gowns are given on yearly basis, value of 3500/- and bed sheets of quantity 2 at Rs. 280/- per bed sheet. The total cost for the laundry is Rs.4060/-.

**8) WATER CHARGES:**

As per the estimates of the assistant executive engineer of civil department of NIMS the average daily consumption of water in MRI per month is 102 KL (kilo litres). The Cost per 1 kl of water is Rs 130/-.

**Water charges for three months = Rs 13,200/- \* 3 = 36,900/-**

**9) MISCELLANEOUS ITEM CHARGES:**

Data about Miscellaneous items like Stationary items, Housekeeping materials etc, was collected from registers of the MRI and general store items. Estimated charges of miscellaneous items is Rs .2,00,000/- per month on an average. The total miscellaneous charges for 3 months of study period is Rs.6,00,000/.

**BREAK EVEN POINT:**

**Break Even Point = Fixed Cost (Equipment Direct+ Labor Direct+ overhead indirect) / (Selling price – Variable Cost per Scan)**

**FIXED COST**

S.No	Cost Center	Fixed Cost in Rs.
1	Equipment cost	13,70,90,000/-
2	Man power cost	53,18,319/-
3	Equipment maintenance	68,54,500/-
4	Building cost	19,18,208/-
5	Building maintenance	1,21,542/-
6	Air conditioning cost	20,30,000/-
7	Air conditioning maintenance	63,750/-
	<b>TOTAL FIXED COST</b>	<b>15,33,96,319/-</b>

**VARIABLE COST:**

S.No	Cost Center	Variable Cost in Rs.
1	Materials	5,03,539
2	Electricity bill	2,55,460
3	Linen	4,060
4	Water consumption	13,200
5	Miscellaneous	3,00,000
	<b>TOTAL VARIABLE COST</b>	<b>10,76,259</b>

#### **SELLING PRICE OF THE SCAN:**

In MRI 3-tesla around 76 various types of diagnosis were undergone with different price list according to the scan. On an average cost for each Rs. 6974/- according to the most frequent scans perform at MRI 3-TESLA.

Additional charges for:

- 1) Interpretation charges Rs.500/- per scan
- 2) Film charges Rs.300 /- per scan

Therefore, the total selling price of scan = avg cost of scan + 1 + 2 = **7774/-**

$$\text{BEA} = \frac{15,33,96,319}{7774 - 415} = \mathbf{20,844.7 \text{ scans}}$$

On an average 28 scans are done per day.

No. of days required to reach the break Even point =  $20845/28 = 744$  days (i.e 2yrs 14 days)

#### **IV. Recommendations**

1. NIMS should have a costing system which will help in developing the user charge packages as per the expenditure occurred on the service and also helps in forecasting of the budget.
2. Average number of procedures done in MRI 3-TESLA of NIMS per day is 28 which can be improved by effective patient flow in the MRI 3-TESLA suite. Having a well-defined flow process can optimize lab utilization. Getting each patient into and out of the procedure room in a timely manner can add minutes and maybe even hours to the daily schedules, allowing for the accommodation of a greater number of cases. Increasing the number of procedures performed per day or week can add to overall income.

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