

A Study on 128 Slice MDCT Unit in a Tertiary Care Teaching Hospital with Special Emphasis on Work Flow and Break-Even Analysis

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ABSTRACT

Purpose: To study the Cost Analysis of 128 Slice MDCT unit in a tertiary care teaching hospital

Materials and methods: The study followed a biphasic design, comprising both retrospective and prospective components. The retrospective phase involved a record-based analysis conducted over a 3-month period, while the prospective phase included record review, observational methods, interviews, and material evaluation relevant to the study, carried out over the course of 1 month.

Results: The cost of running the 128 Slice MDCT unit, including manpower, was calculated for a 3-month period, with an average of 28 cases per day. The unit handles a total workload of 54 TR (15 TR + 35 TR + 4 TR). Power is supplied by a 120KVA UPS located in the unit's UPS room. Depreciation for the building, with a lifespan of 100 years, is set at 1% of the capital cost. For an area of 51.2 sqm, the construction cost totals Rs 19,18,208/-, with a depreciation cost of Rs 47,955/- over 3 months. According to the CPWD manual, the annual maintenance cost is Rs 5104/- per sq.m., resulting in a maintenance expense of Rs 65,331/-. Additional costs for electricity, water, and linen over the 3-month period were also factored in. The breakeven point for the unit is estimated to be 744 days (approximately 2 years and 14 days).

Conclusion: 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.

INTRODUCTION

A CT scan, or computed tomography scan (previously called a computed axial tomography or CAT scan), is a medical imaging technique used in radiology to obtain detailed, non-invasive images of the body for diagnostic purposes. The personnel that perform CT scans are called radiographers or radiology technologists [1,2].

CT scanners utilize a rotating X-ray tube and a series of detectors within the gantry to measure the attenuation of X-rays as they pass through different tissues in the body. These measurements, taken from various angles, are processed by a computer using reconstruction algorithms to generate tomographic (cross-sectional) images, or virtual "slices," of the body. While the use of ionizing radiation can limit its

application due to potential adverse effects, CT is a viable option for patients with metallic implants or pacemakers, where MRI is contraindicated. The system works by rotating an X-ray generator around the object being scanned; X-ray detectors are positioned on the opposite side of the circle from the X-ray source [3]. As the X-rays pass through the patient, they are attenuated differently by various tissues according to the tissue density [4]. A visual representation of the raw data obtained is called a sinogram, yet it is not sufficient for interpretation [5]. Once the scan data has been acquired, the data must be processed using a form of tomographic reconstruction, which produces a series of cross-sectional images [6]. These cross-sectional images are made up of small units of pixels or voxels [7].

Recently demand for diagnose images by CT has grown considerably, with the consequence that increases the radiation dose rates in the population. For this reason, they seek and implement strategies to reduce the dose deposited in patients [8-10]. Automatic exposure control was introduced in CT in the decade of 1990 for procedures in nuclear medicine and radiation therapy [11], which consists in change levels of current that feeds the X-ray tube as soon as scanning takes place in proportion to the density of tissues which attenuate the X-ray beam. This type of control is used most frequently in chest routines because in this area has a higher variation in lateral and frontal diameters.

Photon-counting CT scanners with Quantum Technology revolutionize computed tomography through the Quanta Max detector's direct signal conversion, offering unparalleled precision. SOMATOM Dual Source scanners enhance imaging by using two X-ray sources and detectors simultaneously, improving quality and speed. iMAR technology reduces metal artifacts, producing clearer images for patients with implants. Dual Energy CT enables color-coded iodine mapping to assess organ perfusion, characterize lesions, and perform myocardial blood-pool imaging, crucial for diagnosing cerebrovascular disease and evaluating stroke. It also helps distinguish benign from malignant lesions, rapidly identifies kidney stones, and assesses lung disease and pulmonary embolism, enhancing clinical decision-making and patient care.

AIM

To study the Cost Analysis of 128 Slice MDCT unit in a tertiary care teaching hospital

OBJECTIVES

1. To study the existing physical facilities of 128 Slice MDCT unit
2. To estimate the current work flow in 128 Slice MDCT unit
3. To analyse the cost of 128 Slice MDCT unit in a tertiary care teaching hospital
4. To evaluate the break-even analysis and calculate break-even point.

METHODOLOGY

STUDY SETTING:

The study was carried out in 128 Slice MDCT unit of Nizam's Institute of Medical Sciences, a tertiary care teaching hospital located in Hyderabad, Telangana, India

STUDY DESIGN:

The study followed a biphasic design, comprising both retrospective and prospective components. The retrospective phase involved a record-based analysis conducted over a 3-month period, while the prospective phase included record review, observational methods, interviews, and material evaluation relevant to the study, carried out over the course of 1 month.

STUDY PERIOD: May 2024 to July 2024

SOURCES OF DATA:

To calculate the expenditure on staff salaries, data was gathered from the academic section, human resources department, and claims department.

- For determining the costs related to the 128 Slice MDCT unit, information was collected from the planning section and finance department.
- Maintenance costs were assessed using data from the electrical engineering department, civil engineering department, and biomedical engineering department. Records were reviewed by checking stock registers in NIMS medical, surgical, laboratory, and nursing stores.
- A direct observational study was conducted to evaluate the existing physical facilities of the 128 Slice MDCT unit.
- Income generation and workload statistics were obtained from the Hospital Management Information System (HMIS), developed by CDAC software solutions.

DISCUSSION

The 128 Slice MDCT unit at Nizam's Institute of Medical Sciences is located on the 2nd floor of the Emergency building (PMMSY) and covers a total built-up area of 54 square meters (581.25 square feet). A waiting lounge accommodates patients and their attendants with three-seater chairs for up to 30 individuals. The unit includes a patient holding area, serving as a pre- and post-procedure observation room where patients are prepared for the procedure and, if necessary, observed afterward. This room features a nurse's station for administrative tasks, along with a trolley, two wheelchairs, and an oxygen manifold. The console room, adjacent to the patient holding area, is equipped with split air conditioning. The equipment room houses the 128 Slice MDCT scanner, while the reporting room, next to the console room, is equipped with an X-ray screen. The report typing room contains two computers for typing reports reviewed by doctors. Lastly, the reception area manages appointment scheduling and serves as the location where patients can collect their reports.

EQUIPMENT: The 128 Slice MDCT scanner, model SOMATOM Definition AS Plus-96940, was supplied by Siemens Healthcare Pvt. Ltd., along with accessories, dual energy acquisition, monoenergetic imaging applications, and site preparation. It was installed on the 2nd floor of the Emergency Block on 23-07-2018 and has been functioning smoothly since installation.

STAFFING: 128 Slice MDCT services are provided on 24*7 basis for the convenience of the patients. The details of staff posted at 128 Slice MDCT unit is depicted in the following table:

SI No	Designation	No of staff
1	Professor	1
2	Associate professor	1
3	Resident doctors	3
4	Nurses	1
5	Technicians	5
6	Record assistant	4
7	Class IV Employees	3

WORK LOAD:

S.NO	MONTH	INVESTIGATIONS
1	May-2024	843
2	June-2024	857
3	July-2024	829
4	Total	2529

Average daily cases = 28

UNINTERRUPTED POWER SUPPLY:

Uninterrupted power supply is provided by the 120KVA UPS located in the UPS room of the 128 Slice MDCT unit.

AIR CONDITIONING:

Each procedure room is provided with a 7.5 TR ductable split air conditioning system and the remaining area of 128 Slice MDCT unit is provided with 35TR of Centralized A/C. Each console room is provided with a 2 TR split A/C. Total load of the 128 Slice MDCT unit is 15 TR+35 TR+ 4 TR=54 TR.

TABLE: COST CENTRES ASSOCIATED WITH 128 Slice MDCT unit.

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 cost for three months (study period) = 53,18,319

MATERIAL COST:

Direct Material cost of the 128 Slice MDCT unit includes:

Contrast agents

Anaesthesia

The cost for 3 months incurred where Rs.9662/-

Indirect Material cost of the 128 Slice MDCT unit includes films, stationary, requisition forms, injections, report printing paper, log books, covers. The cost details from the month of May 2024 to July 2024 is Rs.5,03,539/-

EQUIPMENT COST: As per the information from the records of planning department 128 Slice MDCT unit is purchased for a sum of Rs 6,11,87,111/- in the year 2018. The equipment is under warranty for a period of 4 years. The life of equipment is taken as 10 years as per the advice 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 1sqm 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

$$8256+65331 = 73587 \text{ for 3months}$$

i) INSTALLATION COST OF AC:

Load of 128 Slice MDCT unit in the central A.C plant is 35TR. 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 128 Slice MDCT unit = 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 128 Slice MDCT unit = a+b+c = Rs.20,30,000/-.

Maintenance Cost of AC:

The annual maintenance cost for the central AC system in the 128 Slice MDCT unit is Rs 52,000/-. As the two split air conditioners and ductable split air conditioners are under warranty, no maintenance charges apply for them.

Cost of Electricity:

In collaboration with the electrical engineer, the total daily electricity consumption was calculated. The cost was determined at Rs 8.5 per unit. The estimated power consumption is 3340.48 KWH per day, equating to Rs 28,394.08/- daily at a rate of Rs 8.5 per unit. The estimated monthly electricity cost for the MRI unit is Rs 8,51,820/-. The total electricity cost for three months amounts to Rs 25,55,460/-.

Cost of Linen and Bedsheets:

Linen gowns are provided annually at a cost of Rs 3,500/-, and two bedsheets are supplied at Rs 280/- each, totaling Rs 560/-. The overall laundry cost amounts to Rs 4,060/-.

Water Charges:

According to the estimates provided by the assistant executive engineer of the civil department at NIMS, the average monthly water consumption for the 128 Slice MDCT unit is 102 KL (kiloliters). At a rate of Rs 130/- per KL, the water charges for three months total Rs 36,900/- (Rs 13,200/- per month).

Miscellaneous Item Charges:

Data on miscellaneous items, such as stationery and housekeeping materials, was gathered from the general store registers. The estimated monthly cost for miscellaneous items is Rs 2,00,000/-, resulting in

a total of Rs 6,00,000/- for the three-month study period.

BREAK EVEN POINT :

$$BEA = \frac{\text{Fixed Cost (Equipment Direct+ Labor Direct+ overhead indirect)}}{(\text{Selling price} - \text{Variable Cost per Scan})}$$

FIXED COST

S.No	Cost Center	Fixed Cost
1	Equipment cost	13,70,90,000/-
2	Manpower 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/-
8	Total fixed cost	15,33,96,319/-

VARIABLE COST:

S. No	Cost center	Variable cost
1	Materials	5,03,539
2	Electricity bill	2,55,460
3	Linen and bed sheets	4,060
4	Water consumption	13,200
5	Miscellaneous	3,00,000
6	Total	10,76,259

SELLING PRICE OF THE SCAN:

At the 128 Slice MDCT unit, various diagnostic procedures are carried out, each with a specific price depending on the type of scan. The average cost for the most frequently performed scans is Rs. 6,974/-.

Additional fees include:

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

Thus, the total price of a scan is calculated as follows:

$$\text{Total scan price} = \text{Average scan cost} + \text{Interpretation charges} + \text{Film charges} = \text{Rs. } 6,974 + \text{Rs. } 500 + \text{Rs. } 300 = \text{Rs. } 7,774/-$$

$$BEA = \frac{15,33,96,319}{7774 - 425}$$

$$= 20,873 \text{ scans}$$

On an average 28 scans are done per day.

$$\text{No. of days required to reach the breakeven point} = \frac{20873}{28} = 745 \text{ days (2yrs 15 days)}$$

Data Availability Statement: No datasets were generated or analysed during the current study.

RECOMMENDATIONS

1. NIMS should implement a costing system to help develop user charge packages based on the actual expenses incurred for services. This system would also assist in accurate budget forecasting.
2. The 128 Slice MDCT unit at NIMS currently handles an average of 28 procedures per day, which could be increased with more efficient patient flow management. A well-defined process for patient movement in and out of the procedure room can optimize the use of the lab, saving time and allowing for more cases to be accommodated. Increasing the number of procedures performed daily or weekly would contribute to a higher overall income.

Conflict of Interest: None declared

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