A Comprehensive Break Even Analysis of MRI and CT Unit of a Tertiary Care Hospital in Sikkim

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Abstract

Break Even Analysis has wide application in most of the industries but its application so far is limited in hospital industry, this study attempts to perform break even analysis of both MRI and CT unit of a tertiary care hospital in North Eastern state of India, Sikkim. In this study the MRI machine was found to be underutilized with a utilization coefficient of 48%, whereas the CT machine utilization was acceptable with a utilization coefficient of 73%. In this study the MRI unit was incurring a loss of Rs 1837.39 per scan whereas the CT unit was making a profit of Rs 891 per scan. Moreover, the break-even point for MRI is found to be 203 scans per month, the current average scan per month was 138, similarly for CT the calculated break even point was 308 scans and the current average CT scans done were 550 scans per month. This study also uses the break-even selling price calculation to determine the price revision for MRI assuming that the number of MRI scans per month will remain 138 only and after doing the calculation it was found that the average selling price per MRI scan should be Rs 6231 i.e. an increase of Rs 1837 per scan from the existing average selling price of Rs 4394. However, revision of price should not be seen in isolation but together with the competitor's prices, and anticipated reduction in cases because of price elasticity.

Keywords: *Break Even Analysis, MRI, CT, Utilization Coefficient, Variable Cost, Fixed Cost*

Introduction

In India the private sector fulfils almost seventy percent healthcare needs of Indian citizens [(1)].Hospitals otherwise are labour and cost intensive organizations with a long gestation period for giving back profits or attaining Break Even Point. This is due to the fact that almost 60 percent of the expenditure in setting up a hospital goes to the equipment's section and only radiology department consumes around 10 percent of the budget in the teaching hospitals [(2)]. Hence it becomes imperative for the hospital administrators to exercise cost control especially in the radiology department. Break even analysis also called as cost volume relationship basically helps managers by serving three functions i.e. determining the number of units to be produced to reach no profit no loss situation, the price to be charged, and to determine the volume to achieve a target profit. It also helps in determining whether the current performance of a service in the long run will be profitable or not? The fundamental concept of break-even analysis is that profit changes with changes in volume, costs and revenue[(3)].

Radiology department comes under clinical supportive services in a hospital[(4)]. Regardless of whether the hospital is not-for-profit or for-profit, anoptimally functioning radiology department would surely increase the profitability of the hospital.

This study was carried out in a 500 bed tertiary care teaching hospital which was having one CT machine 64 slice of and one MRI machine of 1.5 Tesla. The study was carried out for a period of two months i.e. from April 2019 to March 2019. The aim of the study was to do the Break-Even Analysis of MRI and CT scan units in radiology department of the tertiary care hospital of Sikkim. The objectives were:

1. To calculate the utilization coefficient of both MRI and CT units.
2. To calculate the unit cost of CT and MRI scan
3. To do the Break-Even analysis of CT and MRI units.

Literature Review: Nowadays radiology department in most of the hospital is also known as imaging department and this has happened with the wide acceptation and reliance on Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). However, these facilities are mostly associated with only tertiary care hospitals or hospitals with adequate patient load otherwise installation of these imaging equipment's won't be profitable for the hospital[4]. CT is a specialised X ray which provides detailed anatomical information of the patient's body whereas MRI helps in differentiation of white and grey matter.

To calculate the utilization coefficient the formula[5] used was,

$$\frac{N}{M} X\ 100$$

Where,

N = Average number of hours the equipment is used per day.

M = Maximum number of hours the equipment can be used per day

Similarly, to calculate break-even analysis contribution margin needs to be calculated first, with the help of the formula

To calculate the Break Even point the formula used was,

To calculate the Break Even selling price i.e. the price that should be charged to achieve break even is the formula used is,

Break Even Price = (Fixed cost X Number of Scans in one month) + (Variable cost per scan X Number of Scansinone month)/Number of Scansinone month

Methodology

The retrospective study was conducted using the data of four months, i.e. (January 2019-April 2019) for calculating Unit Cost and Break Even Point of MRI and CT units. First of all, the unit cost was calculated to find out the cost, the hospital puts in for one MRI and CT scan. The unit cost was then calculated by classifying the costs into Fixed and Variable cost.

The fixed cost included:

- Manpower Cost
- Comprehensive Maintenance Contract (CMC)
- Area used for the procedure
- Depreciation

The variable cost included:

- Electricity Cost
- Consumable Cost

Each cost was considered by taking the average of the cost during the study period (i.e. Jan 2019- Apr 2019).Cost summary per unit scan was calculated by dividing the monthly costs (fixed and variable) with the total number of scans in a month.

Results

Scans per month for MRI and CT was calculated by taking the average of scans done for four months i.e. (Jan 2019 -Apr 2019). On an average there were around 138 MRI scans per month and 550 CT scans per month, similarly the average time per MRI procedure on an average was 50 minutes and for CT scan it was 20 minutes below

Table 1: Average Monthly performance of MRI and CT uni

Description	MRI	CT
Scans per month	138	550
Yearly scans	1656	6600
Average time per procedure(minutes)	50	20
Total machine hours per month	175 (7*25)	250 (10*25)
Total machine hours per year	2100	3000

Table 2 Calculation of utilized Machine Hours per month for MRI and CT units

MRI	CT
Average per day scan = 4 Average procedure time = 50 mins 4*50 = 200 min 200/60= 3.33 hrs per day 3.33*25 =83.3 utilized machine hours per month	Average per day scan = 22 Average procedure time = 20 mins 22*20 = 440 min 440/60 = 7.33 hrs per day 7.33*25 = 183.3 utilized machine hours per month
1000 machine hours utilized per year	2199 machine hours utilized per year

Hence the utilization coefficient calculated for MRI unit it was 48% whereas for CT unit it was 73%, see below

Table 3 Utilization Coefficient

MRI	CT
3.33/7 Hrs = 0.47 0.47*100 = 48%	7.33/10 Hrs = 0.73 0.73*100 = 73%

Moreover, the revenue per scan was calculated by dividing the revenue earned by each month of the study period with the number of scans done in each month and their average was taken.

Hence the average revenue per scan for MRI = 4394.1 and the average revenue per scan for CT = 2258.3

Revenue per month is then calculated by multiplying average revenue per scan with average scans per month.

Therefore, Average scans for MRI = 138

Revenue per month for MRIUnit = 4394.1*138 =6, 06,385.8

Average scans for CT = 550

Revenue per month from CT unit = 2258.3*550= 12, 42,065

The calculation of cost summary per unit scan for MRI and CT unit is given below

Table 4: Calculation of Cost per Scan for MRI and CT

Fixed Cost	MRI	Percentage of Total Cost	CT	Percentage of Total Cost
Manpower Cost	2,249.07	54.41%	505.83	36.69%
Depreciation	2208.12	34.82%	344.1	24.96%
CMC	1,268.11	30.68%	286.45	20.78%
Area used for the procedure	29.41	0.47%	3.07	0.22%
TOTAL	5754.71	92.35%	1139.45	83.34%

Variable Cost	MRI	Percentage of the Cost	CT	Percentage of the Cost
Electricity	200.87	3.17%	43.93	3.19%
Consumable Cost	275.91	4.35%	183.93	13.34%
TOTAL	476.78	7.52%	227.86	16.53%

Total Cost Per Scan	6231.49	100%	1,367.31	100%

Manpower cost of MRI and CT includes the monthly salaries of the technicians, radiologists, HOD, clerk and the general duty workers. The cost per scan was calculated by dividing the salaries with number of scans in a month. The manpower of MRI contributes 54.41% of the total cost and CT contributes 36.69% of the total cost. Similarly, the depreciation of MRI and CT was calculated using the Write down Value (WDV) method as Income tax authorities recognize this method and 20% is used as the depreciation rate. The cost per scan was calculated by dividing the depreciation per month with number of scans in a month. Depreciation of MRI contributes 34.82% of the total cost and CT contributes 24.96% of the total cost. The cost per scan was calculated by dividing the monthly CMC with the number of scans in a month. CMC of MRI contributes 30.68% of the total cost and CT contributes 20.75% of the total cost. The area used for the procedure by MRI was 1075 sq. ft. and area used for the procedure by CT was 520 sq. ft. The cost of 1 sq. ft. was Rs.631. The cost of area was then calculated after taking the depreciation at the rate of 10% for a period of 25 years. The area of procedure for MRI contributes 0.47% of the total cost and CT contributes 0.22% of the total cost. The electricity cost of MRI contributes 3.17% of the total cost and CT contributes 3.19% of the total cost. Consumables contributed 4.35% of the total cost and CT contributes 13.34% of the total cost. Total cost per scan was calculated by adding fixed cost and variable cost. Hence the unit cost of an MRI scan came as Rs 6231.41 and unit cost per CT scan was Rs 1367.31. Lastly to determine the profit and loss situation of both the units the total revenue per scan was subtracted from total revenue and it was found that the hospital was losing Rs 1837.39 per MRI scan and was generating a profit of Rs 890.99 per scan.

Table 5 Calculation of Profit and Loss per scan for MRI and CT

Description	MRI	CT
Total Cost Per Scan (Fixed Cost + Variable Cost)	6231.49	1367.31
Total Revenue Per Scan	4394.1	2258.3
Net Profit Per Scan (Total Revenue – Total Cost)	-1837.39	890.99
Net Profit%	- 41.81%	39.45%

Break Even Analysis: The break-even analysis of MRI revealed that that break-even point for MRI unit is 203 scans per month, see below. Whereas the break-even point for CT unit is 308 scans per month, see below.

Table 6 Break Even Analysis for MRI and CT

Variable	MRI	CT
Total Fixed Cost	(5754.71*1656) 95,29,799.76	(1139.45*6600) 75,20,370
Total Variable Cost	476.78	227.86
Sales Revenue	4394.1	2258.3
Contribution Margin (Sales revenue- Variable cost)	3917.32	2030.44
Breakeven Point (Fixed cost/Contribution Margin)	2432.73 scans per year 203 scans per month	3703.81 scans per year 308 scans per month

Loss of MRI is calculated by using the formula,

Profit = Sales Revenue – Total Cost

= (4394*138) – [(5754.7*138) + (477*138)]

= 6, 06,372 – [7, 94,150 + 65,826]

= 6, 06,372 – 8, 59,976

= Rs. 2, 53,604 Loss per month.

Profit of CT scan is calculated by using the formula,

Profit = Sales Revenue – Total Cost

= (2258*550) – [(1139.5*550) + (228*550)]

= 12, 41,900 – [6, 26,725 + 1, 25,400]

= 12, 41,900 – 7, 52,125

= Rs. 4, 89,775 Profit per month.

From the above calculation it can be seen that the on an average the MRI unit is in the loss of Rs 2, 53,604 per month, on the other hand CT unit is generating a profit of Rs . 4, 89,775 per month.

Discussion

In this present study the calculated cost incurred per MRI came to Rs 6231.49 which is higher than other twostudies, in first study[6] it came to Rs 4447.30 whereas in the another one it was Rs 3500, the same is for CT also as in the present study it came as Rs 1367.31 whereas it was Rs 581.40 in the same study discussed earlier.This difference is there due to the difference in the manpower cost which is in the present study is 36.6% of the total cost whereas in the study done by Rehana et al [6] the manpower cost was only 13.8 percent of the total cost. Moreover the breakeven point for MRI and CT scans in this study came to 203 and 359 respectively whereas in another study it came to 135 scans per month for MRI with a cost of Rs 5339.67 per MRI scan [7]. However the direct labour cost in the study done by satyashanker et al [7] was only 4.54 percent. However, the satyashanker et al studywas done in 2008, nearly 11 years earlier and since then there is a great change in the salary packages of the radiology and imaging staff, In addition to that this hospital is situated in hilly terrain where the availability of qualified medical professional and technicians is a challenge hence the salary packages are also on the higher side. Lastly in the study done by Chakravarty and Naware [8] the break-even point for MRI scan per month came to 153 scans with Rs 4129 cost per scan for MRI scans with contrast. Again, this study was done in 2008 and is from a non-hilly terrain.

We suggest that the hospital administrators should not stop at the calculation of break-even point only, they should also calculate the required selling price to be charged to achieve the break-even point for example in this study it was found that the current MRI scans per month are 135, whereas to achieve break even the hospital needs to do 203 MRI scans per month, In case the increase in volume is not possible then the only way left is increase in the selling price, the hospital should calculate the Break Even selling price for MRI unit with the help of formula

Break Even Price
= (Fixed cost X Number of Scans in one month)
+ (Variable cost per scan X Number of Scans in one month)
/Number of Scans in one month

= [(5754.7*138) + (477*138)]/138

= [7, 94,150 + 65,826]/138

= 859976/138

= Rs.6231 per scan

Current average selling price of MRI in the hospital is Rs. 4394. Therefore, to achieve the break even with the existing number of scans the hospital administration need to ponderupon increasing the price by Rs.1837 to the existing selling price to recover the cost per scan. While taking the decision administration also needs to consider the competitive price in the nearby market and the likely impact of increased price on the volume after considering all this only they should take a final call on price increase.

Conclusion

The application of break-even analysis in hospitals is very limited and it is mostly used only for ascertaining the profit and loss situation of the unit, however there are additional utility of break-even analysis such as used in this study in determining the break-even selling prices and for calculation of target profit. The authors would like to again emphasize that break even analysis should not be seen in isolation and healthcare being a unique industry dealing with human life's there is no room for unethical practises but still break even analysis gives a valuable insight to the hospital administrators especially working in private sector in evaluating their current performance and in determining the future course of action.Lastly, it should be remembered that break even analysis although being a very useful tool haslimitations as well such as difficulty in distinguishing fixed and variable cost, unrealistic assumptions such as the selling price should be constant, when the organization sells more than one product the difficulty in performing break even analysis.

The study is not funded by any agency.

There is no conflict of Interest.

The study was conducted as a part of Internship of healthcare management students and hence there was no Ethical Issues involved, as there was no direct/indirect intervention with any patient or animals.

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