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RESEARCH ARTICLE

BREAK – EVEN ANALYSIS OF MRI UNIT IN A   TERTIARY   CARE ACADEMIC INSTITUTE.

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Manuscript Info	Abstract
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	Objective: To analyze the costs of MRI scanner in the teaching super-specialty Institute.To evaluate the Break-even analysis and to calculate the break-even point. **Rationale:** The financial managers of health care organizations are facing problems in managing high end diagnostic equipment in the cost containment. Accurate cost calculations and the profit estimation are mandatory for health managers. **Method:** The prospective study was conducted in a tertiary care academic Institute, we applied costing method empirically to assess the cost in performing a MRI scan and carried out the Break-Even analysis. **Results:** The total cost for operating the MRI equipment was Rs.19788186 (US\$291184.26), an average of 23 scans were taken in a day. The revenue collection through MRI diagnosis was Rs. 31494441(US\$ 463442.45) in the study year. 7967 scans were performed during the year. The revenue obtained through a scan MRI was Rs.3953.11 (US\$58.19). The BEP of MRI facility was 7830.7. **Conclusion:** This methodology is beneficial to health care manager to identify the profit/loss MRI scanner. The results indicate that the MRI unit was working with profit. It was found that the total number of patients are gradually increasing for MRI scan, the MRI scanning unit already reached the break-even point.

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Introduction:-

Chatterjee (2017) stated that "Health care has become one of the India's largest sectors- both in terms of   revenue and employment, and it comprises of hospitals, medical devices, clinical trials, outsourcing, telemedicine, medical tourism, health insurance and medical equipment." The Indian health care industry amounted to \$110 in 2016 and is expected to reach \$280 billion by 2020 due to increased demand for specialized and quality health care facilities. The Indian Infoline Blog (2016) emphasized   that, "Medical technology is that which extends and improves life, and alleviates pain, injury and handicap. It is an essential component of the health care industry, and constitutes everything from wheelchairs and MRI machines to insulin pens and surgical instruments. There is a growth in the medical device sector, or medical equipment sector, which plays a vital role at every stage of the healthcare continuum." 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 diagnostic market is the fastest growing segment in India, with forecasted to grow to US \$17 billion by 2021 according to Pricewaterhouse Coopers (PwC). Sinha (2018) reported that, unfortunately, 75 percent of the equipment demand for Indian health care is met through

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imports, and there has been substantial increase in customs duty on medical devices (items falling under HSN 9018 and 9021), which has adversely impacted costs of medical equipment and devices in India.

Popesko (2014) emphasized that during last few years the hospitals are facing problems to provide quality medical care like limited resources and   advanced medical technology with huge expenditure. The patients are demanding quality medical care and   standardized premises. The reimbursement from the health insurance system is the   most important source of revenue. Hence   hospitals are under pressure to be more   effective, and   able to provide a sufficient level of care on less money, and   hospitals are forced to adopt cost management techniques.

Health care managers (HCM) should take financial decision in their managerial practice by knowing the financial status, specific needs and   goals as well as mission of the   health care organization (HCO). HCM shall keep an eye on trends in financial practices, which is indeed helpful to HCO. The health care business is a cost intensive practice, the commissioning and maintaining the high end equipment need to be studied and evaluated their feasibility. In HCO the radiology shares 40% to 60% of all medical equipments' cost and consumes 10% of the annual budget as maintenance. 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 behoove 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. (Donai, J,J., (2014), Roshan, K.,(2017), Troelsen, T.,(2006), Aleem, M., (2016), Khurshid, R., Tabish, S, A.,(2014), Choudhary, P, K., (2013), Saywell, Jr, R,M.,).

Martin (2014) stated that "BEA is a managerial tool widely used to evaluate the business performance in terms of costs, it determines the cost structure, and the number of units that need to be sold in order to cover the expenses and to make a profit. It is helpful in pricing and cost control." Following are some important advantages of BEA:
1. It explains the relationship cost, production, volume and revenue.
2. It can be extended to show changes in fixed cost, variable cost, service or commodity prices, revenue will effect   profit levels and break even points.
3. The major benefit is that it indicates the lowest amount of business activity necessary to sustain in business and prevent losses.

Limitations of BEA: BEA is the best suited to the analysis of one product at a time. It may be difficult to classify a cost as all variable or all fixed; and there may be tendency to continue to use a breakeven analysis after the cost and income functions have changed.(Accounting explanation. Com. 2011)
 Break-even point is the level of sales at which profit is zero. At break -even point total sales are equal to total costs (variable + fixed).This study examined the financial BEA and BEP of the MRI facility in large tertiary care teaching institute.

Objectives:-
1. To estimate the costs of MRI unit   in the teaching super-specialty Institute.
2. To analyze   Break-even   analysis and to calculate the break-even point.

Methods:-
The prospective study was conducted in MRI unit of a teaching hospital. We used two management tools step down costing (SDC) method and break-even analysis. The ethical clearance for the study obtained from the institutional ethics committee. Based on the previous studies (Yildrim, S., et al., 2015, Cao, P., et al., 2006, Conteh, L., et al., 2004, Catanzaro, T, E., 2016) we applied SDC method to calculate costs of   MRI facility.The primary data collected through personal discussion with biomedical, electrical and civil engineers, purchase section and stores department personnel and others. The secondary data collected from the reception registers, MRI log book, purchase and stores department registers. Relevant Journals retrieved   from website Google Scholar. A financial break-even-analysis was performed to determine the point where the MRI diagnostic service generated enough revenue to cover its total variable and fixed costs, both direct and indirect. BEA was calculated using the following formula:

BEA   =   <u>Fixed Cost (Equipment Direct+ Labor Direct+ Labor Indirect+ Overheads Indirect)</u>
                     (Selling price – Variable Cost per Scan)

Results:-

Eight distinct costs of MRI were identified and estimated by method of SDC.The machine cost may be divided into fixed costs, operating costs, labor costs and over heads and may be classified into: direct and variable, direct and fixed, indirect and variable and, indirect and fixed.

In our study following types of costs were traced out and distinguished which are identified with MRI unit: I. Fixed cost: 1.Equipment related Direct and fixed (EDF cost), 2. Labor related direct and fixed (LDF cost), 3. Labor related indirect and fixed (LIF cost), 4. Over heads related indirect and fixed (OHIF cost).
II. Variable Cost: 1. Equipment related direct and variable (EDV cost), 2. Material related direct and variable (MDV cost), 3. Material related indirect and variable (MIV cost), 4. Over heads related indirect and variable (OHIV cost).

Fixed: Equipment's direct cost:-
The total equipment MRI direct and fixed cost includes, rent of the MRI unit, interest on the capital payment of MRI, insurance, annual maintenance and uninterrupted power supply's annual maintenance. It was Rupees (Rs) 4753258 (US$ 69944.46; date of conversion 2018 May 19), which was 24.02% of total cost.

Fixed: Labor related direct cost:-
which includes the doctors salaries of MRI unit, technicians salaries, biomedical mechanics, room assistants, other workers and staff medical fund and utility funds, was Rs.1990345 (US$29288.04), which was 10.06% of total cost.

Fixed:Labor related indirect cost:-
which includes the head of department, and office secretarial staff salaries and it was Rs. 313639 (US$ 4615.22), these salaries were apportioned (1/6)and allotted to MRI unit, which was 1.58% of total cost.

Fixed: Over heads related indirect:-
which includes expenses of administration, it was apportioned by (½0) and allotted to MRI unit, was Rs. 370960 (US$5458.70), which was 1.88% of total cost.

Variable: Equipment related direct cost:-
it includes MRI depreciation (Rs 6059550), air handling unit depreciation (Rs 100375), air-conditioning and other support the equipment's depreciation (Rs 66000), civil works depreciation (Rs 275000), repairs and civil maintenance (Rs125000), electricity consumed by MRI equipment (Rs 1145700), electricity consumed by air-conditioning (Rs 882000), and generator fuel expenses (Rs 30440). The MRI related direct and variable expenses for the study period was Rs. 8684065 (US$127786.50), which was 43.88% of total cost.

Variable: Material related direct cost:-
which includes the expenses for MRI films (Rs 2378839), customized covers (Rs 80263), report forms (Rs 1374), requisition forms and others (Rs 6934), laser printer (Rs 203190), and contrast agents (Rs 231567). This expenses for the year was Rs. 2902167 (US$42705.55), which was 14.66 % of total cost.

Variable: Material related indirect cost:-
which includes injections (Rs 10594), surgical utilities (Rs 33079), surgical spirit (Rs 861), dettol (Rs 437), injection dextrose normal saline (Rs 2475) and isolate pediatric use (Rs 152). The expense for one year was Rs. 47598 (US$700.41), which was 0.24% of the total cost.

Variable: Over heads related indirect cost:-
which includes telephone and IT, consumables, printing and stationary, postage, housekeeping, water, sewage, MRI books and journals, and it was Rs.726154 (US$10685.40) which was 3.67% of total cost.

Table 1:-The total number of cases in 4years

Year	MRI scans	% of increase to previous year
1 year	6845	
2 year	6415	-6.25
3 year	7985	24.435
4 year	7967	-0.23

Total	29214	Average scans: 7303.5/ year

Table 2:-Types of costs of MRI: Indian Rupees

S.No	Types of costs	Cost in Rupees
1	Fixed :Equipment Direct	4753258
2	Fixed: Labor Direct	1990345
3	Fixed: Labor Indirect	313639
4	Fixed: Over heads Indirect	370960
5	Variable: Equipment Direct	8684065
6	Variable: Material Direct	2902167
7	Variable: Material Indirect	47598
8	Variable: Over heads Indirect	726154
		19788186

Table 3:-Revenue generated at MRI and types of cost incurred at different levels of activity.

Units	Sales(revenue)	Variable cost	Marginal cost	Fixed cost	Total cost	Net Income
6000	15000000	9308400	5691600	7428202	16736602	-1736602
6500	16250000	10084100	6165900	7428202	17512302	-1262302
7000	17500000	10859800	6640200	7428202	18288002	-788002
7500	18750000	11635500	7114500	7428202	19063702	-313702
7830.7	19576750	12148547.98	7428202.02	7428202	19576749.98	0.02
8000	20000000	12411200	7588800	7428202	19839402	160598
8500	21250000	13186900	8063100	7428202	20615102	634898

Fig 1:-MRI facility Break-Even Analysis and Break-Even Point
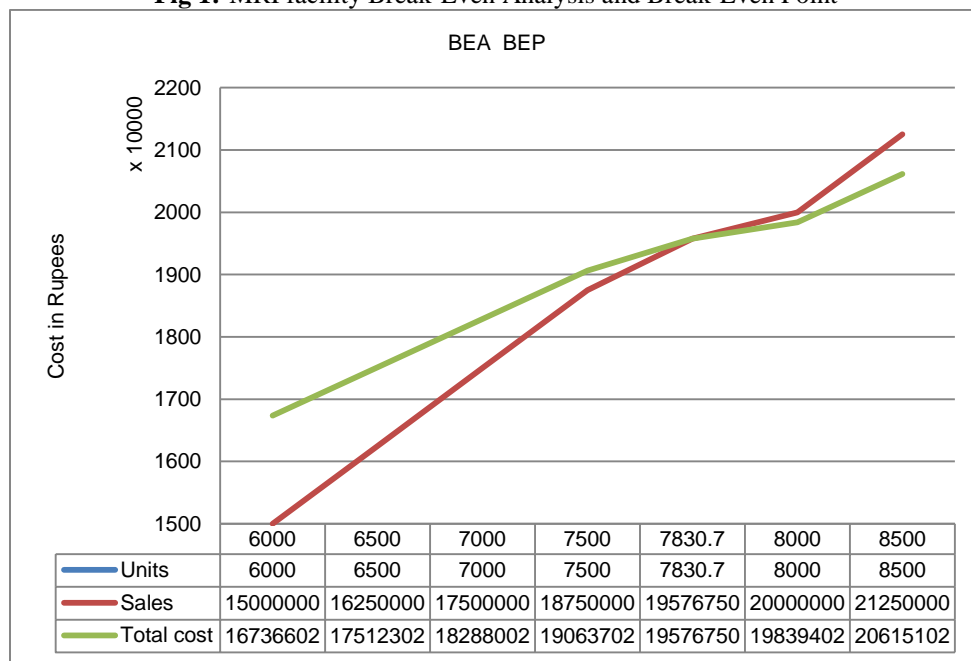
	6000	6500	7000	7500	7830.7	8000	8500
Units	6000	6500	7000	7500	7830.7	8000	8500
Sales	15000000	16250000	17500000	18750000	19576750	20000000	21250000
Total cost	16736602	17512302	18288002	19063702	19576750	19839402	20615102

BEA   =   Fixed Cost (Equipment Direct+ Labor Direct+ Labor Indirect+ Overheads Indirect)
              (Selling price – Variable Cost per Scan)

$$= \frac{7428202}{2500 - 1551.40} = 7830.7$$

The study obtained the total cost for operating the MRI equipment was   Rs.19788186 (US$291184.26), shown in Table 2. An average 23 scans were taken in a day. The revenue collection through MRI diagnosis was Rs. 31494441(US$ 463442.45) in the study year. 7967 scans were   performed during the year. The BEP of MRI facility was 7830.7. This facility reached BEP. The revenue obtained through a scan MRI was Rs. 3953.11 (US$58.19) which was profitable.

Discussion:-

From the study, MRI Break-even analysis, we found that the variable cost was the highest cost. The total variable cost was INR 12359984 ((US$ 231633.88) and VC per a scan INR 1551.40((US$29.07). The total Fixed Cost was INR 7428202((US$13909.34). The BEP 7830.7 was that the number of patients required for MRI to get profit. The total of 7967 MRI scans were performed in the year, MRI scan unit reached the optimal level of efficiency in terms of finance. The results are compared to the findings of Khurshid and Tabish et al.,(2014). In their study they found that, the fixed cost was Indian Rupees 4025.90 (US$ - 75.44) per scan, the variable cost was Indian Rupees 420.28 (US$ - 7.87) per scan,   BEP was 2481.4 units. In their hospital to make profit the average need of MRI scans was 413.35 scans per month, but the facility utilization was 213.4 scans per month. In another study conducted Sathyashankar et al.,(2014), the fixed cost was Indian Rupees 3046 (US$ - 57.08) per scan, the variable cost was Indian Rupees 2293 (US$ - 42.97) per scan, BEP was 1615.10 units.

Conclusion:-

In the currentera there is great importance for the costing methodology and a Break-even analysis in the health care service sector. The health care organization intended to provide quality medical care along with an intention to cost containment. The profit position of a service unit can be elucidated with an elite method Break-even analysis. The major objective of this study was the BEA of the MRI scanner unit. Overheads are one of the major contributing factors which determine the hospital profits. If hospital could properly control over processing the overheads they can fix the price of the diagnostic service efficiently. Hospitals follow different costing methods like marginal costing, absorption costing, step down costing etc. Our study elicited that the step-down costing method was an appropriate method for a BEA. It is useful and important tool for managers dealing with finance. It was found that the total number of patients gradually increasing for MRI scan, the MRI scanning unit already reached the break-even point, therefore the hospital can plan for another MRI with more Tesla. The net working in the catchment area hospitals appear to be the best strategy for achieving more financial benefits.

 In the future this type of study can be conducted to examine the plus points and drawbacks cost method and BEA to other areas like O.Ts ICUs, and supportive units diet and pharmacy. The managerial decision in finance matters of a unit, the BEA could yield better results for policy making and decision making in expanding the services. In MRI facility the different types of MRI scans are provided to each patient and each type have different price, therefore multiple service break even analysis may be more appropriate method in future research.

Limitation:-

The results and findings of the study were extracted from post graduation thesis work. We acknowledge the serious limitation of the article upfront, the results were utilized in another article published by the author, "To study Comprehensive machine hour rate analysis of Magnetic Resonance Image in a tertiary care teaching institute" IJSR vol:7(7) July 2018**.** However the methodology of the article is highly relevant and topical to   hospital administrators in financial management of hospitals.

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