Cost-effectiveness Analysis for Technology Acquisition

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Abstract

Background: In a developing country with limited resources, it is important to utilize the total cost visibility approach over the entire life-cycle of the technology and then analyse alternative options for acquiring technology.

Methods: The present study analysed cost-effectiveness of an “In-house” magnetic resonance imaging (MRI) scan facility of a large service hospital against outsourcing possibilities. Cost per unit scan was calculated by operating costing method and break-even volume was calculated. Then life-cycle cost analysis was performed to enable total cost visibility of the MRI scan in both “In-house” and “outsourcing of facility” configuration. Finally, cost-effectiveness analysis was performed to identify the more acceptable decision option.

Result: Total cost for performing unit MRI scan was found to be Rs 3,875 for scans without contrast and Rs 4,129 with contrast. On life-cycle cost analysis, net present value (NPV) of the “In-house” configuration was found to be Rs-(4,09,06,265) while that of “outsourcing of facility” configuration was Rs-(5,70,23,315). Subsequently, cost-effectiveness analysis across eight Figures of Merit showed the “In-house” facility to be the more acceptable option for the system.

Conclusion: Every decision for acquiring high-end technology must be subjected to life-cycle cost analysis.

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Key Words: Technology assessment; Cost benefit analysis; Cost-effectiveness analysis

Introduction

Twentieth century has witnessed advances in technology, which in turn have made an unprecedented demand on hospital medical services [1]. The aim of any health care system is to maximize health, but resources will always be scarce in relation to the health care needs. Those responsible for allocating resources need to prioritise between competing claims so that maximum benefit can be obtained from a given budget [2].

While the physicians in recent years have acknowledged the desirability of providing more cost-effective medical care, this goal is infrequently attained in practice due to absence of adequate data on the cost-effectiveness of alternative diagnostic and therapeutic strategies [3]. The failure of the concept of medical necessity to address differing priorities has led many to advocate cost-effectiveness as a basis of clinical choice. However, methods used to define and assess cost-effectiveness of a system vary [4]. An intervention or technology is considered cost-effective if there is no other alternative intervention that offers appropriate benefit at a lower cost [5]. There is a need to address the downstream cost impact produced by utilization, maintenance and support of a system through its planned life cycle while taking a decision on technology

acquisition.

A study was carried out to analyse long-term cost impact of establishing an in-house magnetic resonance imaging (MRI) scan centre at a large tertiary care hospital with a view to evolve a decision matrix for cost-effectiveness analysis of the scan centre vis-à-vis alternative outsourcing possibilities.

Material and Methods

Operating costing method was utilized to estimate cost per unit scan performed at the MRI centre [6]. Necessary inputs for the costing were obtained by direct observation, interview with staff and perusal of documents maintained. Cost inputs were initially divided into fixed and variable cost. Total cost for functioning of the MRI centre was divided by the total number of procedures performed at the centre to arrive at the cost per unit procedure. Subsequently, break even analysis was performed to determine the break even volume i.e the number of procedures to be performed beyond which all marginal contributions (Revenue-Variable cost) will represent income for the hospital. Volume of MRI scans to be performed during the first year of installation were assumed to be the volume performed during the year of the study. Further, the volume of procedures was also assumed to be increasing by 10% every year as per the present trends till fourth year, after which the volume is expected to stabilize as the demand for scans is primarily supplier-induced.

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Life cycle cost analysis was performed to ensure total cost visibility for the entire life span of the MRI scan equipment, which was assumed to be 10 years. All the cost categories that have been identified during cost estimation of MRI procedures were included in the cost break down structure of the life cycle of the equipment. For ease of calculation, 60% of all scans to be performed per year were assumed to be without contrast and 40% with contrast. Break even volume was assumed to be same for the entire life cycle of the equipment. Cost for each year of the life span of the equipment was estimated by multiplying the expected number of procedures in the whole year with the cost of performing an unit procedure. All procedures beyond the breakeven volume were also multiplied by the contribution margin to arrive at the expected benefit gained by the hospital because of having in-house MRI facility.

Life-cycle cost profile for a hypothetical situation of outsourcing the MRI scan was also developed for a life span of ten years. Rates for unit MRI scan laid down as investigation charges for non-entitled patients in armed forces hospitals vide Army HQ letter No 76787/DG-5B dt 29 Sep 05 was considered while calculating the cost profile. The entire capital cost for establishing MRI centre was considered as an opportunity cost for the organization.

Costs for each year in the life-cycle of the MRI centre in both the situations were then discounted to its present value. A discounting value of 10% was assumed for annual compounding. Benefit and cost in respect of cash flow for each year of the life cycle was multiplied by the discounting factor (worked out from a standardized table of interest factors for annual compounding) to arrive at the present value of the cash flow concerned. Net present value (NPV) for both the options along with various intangible but critical Figures of Merit (FOM) were then charted against each decision options to create a decision matrix for cost effectiveness analysis.

Results

The fixed cost for performing unit MRI scan was Rs.3,544.32. The variable cost was Rs. 330.56 in scans without contrast and Rs.584.89 with contrast. Total cost per unit procedure performed at the MRI centre was calculated to be Rs.3,875 for scans without contrast and Rs.4,129 with contrast (Table 1). Life cycle cost analysis of the in-house MRI centre showed a NPV of Rs.(-4,09,06,265) (Table 2) while similar analysis performed with the same costing data in a hypothetical situation of outsourcing of the entire responsibility to a civil vendor showed a NPV of Rs. (-5,70,23,315) (Table 3). Decision analysis was then performed against both tangible and intangible factors to assess the cost effectiveness of the in-house MRI scan centre vis-à-vis outsourcing of this modality (Table 4).

Discussion

Medical education has traditionally been devoid of any coverage of medical costs and related economic issues. One of the reasons for this inattention is that the perspective of the economist regarding the necessary

tradeoffs between health services and other societal priorities is frequently at odds with the traditional role of the physician to do everything possible for the patient.

By accepting the need for cost-effective medical decision making, health care practitioners are looking for newer strategic tools to control costs without affecting the quality of patient care. Outsourcing has been identified as one such tool which is characterized by transferring services or operating functions to a third party service provider and controlling the sourcing through contract and partnership management. However, outsourcing also leads to a relative loss of control over the particular function, which may lead to problems for the hospital manager in the event of sub-optimal vendor performance.

In our study, the cost of performing unit MRI scan compares favourably with the rates for similar investigations being charged by civilian institutions in the same city. Break even analysis is a popular tool for the managers to analyse operating leverage of alternative decision options and in the present study, the break even volume was found to be 1838 MRI scans, beyond which all additional scans will generate revenue for the organization in the form of contribution margin. In our study, the MRI scan facility will break even from the first year onwards, with the underlying assumption for constant demand for MRI scans in the future.

While acquisition cost remains an important factor for decision making on technology acceptance, total cost visibility over the entire life cycle of the system has become an important FOM during the early stages of planning. It is not only the acquisition cost but costs of operating and maintaining the system that gives real cost visibility of the technology proposed to be acquired and thus a life cycle approach is required while planning for any new system [7].

Table 1
Cost estimation of unit MRI scan

Cost category	Total cost/year (Rs)	Cost/unit scan (Rs)
Fixed cost		
Staff Salary	6,56,400	271.00
Maintenance cost of MRI	33,00,000	1362.51
Depreciation cost of equipment and fixed assets	46,28,000	1,910.81
Variable cost		
Electricity	2,50,100	103.26
Reagents & consumables	5,50,543	227.30
Contrast (gadolinium)	6,16,000	254.33
Cost/unit MRI scan		Rs 3,875*
		Rs 4,129**

* without contrast

** with contrast

Table 2**Cost profile of In-house MRI facility**

Year	Break-even volume	Expected number of scans	Cash flow		Discount factor (10%)	Present value	
			Benefit	Cost (Rs)		Benefit	Cost (Rs)
1	1838	2400	2041660	95,43,840	.9091	1856073	86,76,304
2	1838	2640	2917600	1,04,98,224	.8264	2411104	86,75,732
3	1838	2904	3887090	1,10,23,596	.7513	2920370	82,82,027
4	1838	3194	5252450	1,11,19,296	.6830	3587423	85,94,479
5	1838	3194	5252450	1,11,19,296	.6209	3261246	69,03,970
6	1838	3194	5252450	1,11,19,296	.5645	2965008	62,76,842
7	1838	3194	5252450	1,11,19,296	.5132	2695557	57,06,422
8	1838	3194	5252450	1,11,19,296	.4665	2450267	51,87,151
9	1838	3194	5252450	1,11,19,296	.4241	2227564	47,15,691
10	1838	3194	5252450	1,11,19,296	.3856	2025344	42,87,600
Total present value						26399953	6,73,06,218
Net present value (NPV) =Rs - (4,09,06,265)							

Table 3**Cost profile of outsourcing of MRI facility**

Year	Cash flow		Discount factor (10%)	Present value	
	Benefit	Cost (Rs)		Benefit	Cost (Rs)
0	5,60,00,000 (Opportunity cost)	0	1.000	56000000	0
1	0	1,48,80,000	.9091	13527408	
2	0	1,63,68,000	.8264	0	1,35,26,515
3	0	1,79,80,000	.7513	0	1,35,08,374
4	0	1,98,10,000	.6830	0	1,35,30,230
5	0	1,98,10,000	.6209	0	1,23,00,029
6	0	1,98,10,000	.5645	0	1,11,82,745
7	0	1,98,10,000	.5132	0	1,01,66,492
8	0	1,98,10,000	.4665	0	92,41,365
9	0	1,98,10,000	.4241	0	84,01,421
10	0	1,98,10,000	.3856	0	76,38,736
Total present value					56000000
Net Present Value (NPV) = Rs - (5,70,23,315)					11,30,23,315

Table 4**Decision Matrix: Cost-effectiveness analysis of MRI centre**

Figures of merit (FOM)	In-house MRI scan facility	Outsourcing of MRI scan facility
Net Present Value (Rs)	-4,09,06,265	-5,70,23,315
Expectation of patients for all services in a single complex	Fully satisfied	Not satisfied
Convenience of OPD patients	Very convenient	May be inconvenient
Need of clinicians for early diagnosis	Fully satisfied	Fully satisfied
Reliability of report	Fully reliable	May not be fully reliable
Availability for emergency use	Available	Not available
Need for training and research of personnel	Fully satisfied	Not satisfied
Image of hospital	Value addition to the image	May not be true

Every alternative configuration with different cost profile needs to be related to an equivalent basis, which is usually done by discounting the costs of each year in the life cycle of each alternative being evaluated to its present value. Discounting allows for the evaluation of the time phased profile of cost streams for various

alternative configurations at its present value by application of a selected rate of interest to measure differences in preference between money at its present value and its anticipated value in future [8].

In the present study, cost-effectiveness analysis across eight FOM shows that “In-house facility” is more

acceptable than the “Outsourcing of facility” configuration. However, it needs to be appreciated that rigorous price negotiation and promise of bulk scans per year may persuade a civil vendor to quote lesser rates for MRI scans, thus bringing down the cost profile of the “outsourcing of facility” configuration and in such cases, the life-cycle cost parameter may dominate other FOM in a developing country like India while making an informed choice for high-end technology acquisition.

Conflicts of Interest

None identified

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Book Review

Microbial Forensics. Roger G Breeze, Bruce Budowle, Steven E Schutzrer, editors. Burlington: Elsevier Academic Press USA. Pages-425; Price INR-5000/-ISBN No. 0-12-088483-6.2005

Pathogenic microbes have assumed a grave threat to mankind in recent times and the capability to manipulate and disseminate pathogens as weapons is a reality. This book for the first time introduces the new discipline of Microbial Forensics, which is dedicated to analyzing evidence from a bioterrorism act, biocrime or inadvertent micro organism/toxin release for attribution purposes. With contributions from a wide range of experts, it defines the concept of microbial forensic in the first chapter and how it differs from forensic medicine, before going onto the fundamentals of infectious diseases and the common viral and bacterial pathogens that one is likely to encounter. Using current scientific techniques it elaborates how we should go about investigating bioterrorist/biocrime events to help identify the perpetrators and exonerate the innocent.

The book describes in detail how the various pathogens and their toxins can be tracked, besides determining the presence of engineered viruses which can be so easily manipulated in today's world of biotechnological advancement.

Guidelines and protocols to aid microbiologists and clinicians in undertaking investigations when ever a cluster of unusual cases occur in the community is practical and extremely relevant. The last five chapters deal with practical details about investigations in suspicious disease outbreak, team composition, evaluation of clinical findings, collection, transport and storage of specimens, sample handling and laboratory analysis. Non DNA methods have also been included to corroborate findings and results, so that evidence can be substantiated in a court of law for attribution purposes.

The last few chapters on bioinformatics and quality management with admissionability standards for scientific evidence make it a complete treatise on microbial forensics. It is a book which must be read by all microbiologists and clinicians besides post graduates, keeping in mind the current the current world scenario where the threat of bioterrorism is a reality.

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