Operating Manifold Services in Hospitals: A costly affair?

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***Abstract*- Manifold services form an important cost centre in hospitals. Most public sector hospitals do not have standard cost accounting system and therefore budget allocation is often difficult for support services such as the manifold. The study was conducted in a 1045 bedded tertiary care hospital in New Delhi, India with the objective of identifying the cost incurred in delivery of manifold services.**

This traditional costing exercise was conducted from 01 July to 30 Sept 2010 and included classification of costs, identification of the cost centres in the hospital, cost allocation and apportioning. Direct and indirect costs as well as capital and operational costs were calculated. The process of manifold services from delivery to the operational aspects was studied. Tender documents and supply orders were perused to arrive at expenditure on manifold gas pipeline system, equipment & accessories. Total annual cost of manifold services at the hospital was calculated to be $ 333,676 and per day cost was calculated to be $ 941 .Annual cost per manifold terminal unit was $ 207.3. The daily cost of manifold system was calculated to be $ 0.56. The annual and daily cost per bed was deduced to be $ 320 and $ 0.87 respectively.

While manifold is a vital support service, the fact remains that it is cost intensive and underutilized and often poorly planned in terms of cost effectiveness. The focus on technology in manifold services needs to be sustained.

Keywords- Cost centers, Manifold gas pipeline system traditional costing,

I. INTRODUCTION

A medical gas is defined as one that is manufactured, packaged, and intended for administration to a patient in anaesthesia, therapy, or diagnosis[1]Most public sector hospitals do not have standard cost accounting system and therefore budget allocation is often difficult. In the current dynamic scenario of technological development and newer facilities, it is important to know how budgetary allocation may be done to make it commensurate with the inflation. Therefore, a study was conducted with the objective of identifying the cost incurred in delivery of manifold services at an apex tertiary hospital in India.

II MATERIAL AND METHODS

The study was conducted at a 1045 bedded, public sector tertiary hospital in New Delhi, India from 01 July to 30 Sept 2010. This costing exercise included classification of costs, identification of cost centres, cost allocation and apportioning.[2] Both direct and indirect costs were calculated.

Traditional or average costing methodology was used to arrive at the costs. Process mapping of Manifold service were done to calculate of the cost of the process of manifold delivery[3][4] Unstructured interviews were held with the key informants. In consonance with the WHO guidelines, the cost was divided into Capital and Operating cost.[5]

Land cost (donated by the Govt.), minor costs such as stationery, linen, cost of water and all areas under renovation with new manifold being laid down were excluded. The cost centers were as follows:

1. **Capital cost:**
   a. **Building cost:** Replacement cost method was used to arrive at the current construction cost, based on current Central Public Works Department (CPWD) construction rates and using CPWD cost index for 2010. The ground area was physically calculated. Life of the building, assumed as 100 yrs and annual cost of the building was calculated using straight line method of depreciation.
   b. **Cost of equipment, fixtures and fittings***:* Equipment & furniture inventory information and cost incurred was taken from the stores department. Annualized cost was calculated using straight line depreciation method using the formula: Depreciation per annum=(Cost-Residual value)/useful life. The useful life was taken as ten yrs. The total manifold gas pipeline system (MGPS) currently commissioned were assessed considering the replacement cost as on date. Cost of manifold accessories was calculated as such since maintenance and replacement were also catered for in the contract. Surgical Stores records from the year 2006 to 2010, pertaining to manifold items were studied for evaluating of replacement cost.
2. **Operating Cost**:
   a. **Building and Equipment Maintenance Cost:** Maintenance cost of the building was fixed as per the rates prescribed by the CPWD memorandum and adjusted to inflation for the year 2010. The cost of maintenance of the equipment was already part of the contract drawn.

DOI: 10.5176/2345-718X_1.2.28

b. Consumables*:* Costing of the manifold gases was done by calculating the monthly consumption and multiplying it with rate per unit. The Stores Department monthly inspection – notes, supply orders and records from manifold services were perused to arrive at the annual consumption of liquid oxygen and three months consumption of manifold gases. General store items were also included in the study**.**

c. Electricity: The electrical load and consumption was calculated by studying actual functional hours of machinery and equipment. The cost was calculated on the basis of actual as charged by New Delhi Municipal Corporation (NDMC). To this ten percent was added for the maintenance of the 11 KV sub-station**.** The electricity consumed by each system was calculated as Units/hr X no. of hrs. X days X Per unit NDMC rates.

d. Manpower cost: Cost of manpower directly associated with functioning of the manifold services were included in the study and their total salaries were considered for cost analysis**.**

The rate of conversion from Indian Rupee (INR) to US dollars was fixed at One US dollar (USD)= 45 INR (averaged for the study duration).

III RESULTS

The hospital had a total of 1045 beds and 1600 manifold outlets and nearly 20 kilometres of MGPS at the time of the study. The manifold facility is a combined oxygen and nitrous oxide gas cylinder storage room with an adjoining area housing liquid Oxygen tank of 11,043 ltr (Gross capacity 12270 L) capacity weighing 7376 kgs.

Capital Cost

Building Cost: Total area of the manifold facility was 117.76 sq.m. The per square meter building cost, after incorporating the CPWD cost index for 2010(136), was calculated to be $ 909 (INR 31,903) and annual building cost of manifold (considering One percent annual depreciation) for year 2010 was $ 834.4(INR 37,549)

Manifold Equipment Cost*:* The institutional capital cost for the liquid oxygen tank was nil since the cost was borne by the contracted firm. The cost of manifold facility equipment was derived to be $ 279,412.7 (INR 1,25,73,572) and cost of accessories $ 46,000 (INR 20,70,004). The annualised equipment cost including accessories was found to be $ 32541 (INR 1464357) Considering the depreciation of ten percent, the annual cost was $ 673.1(INR 30,230). The total length of pipelines was found to be 206,200 mtrs. Replacement cost was used to find out the rates of the various dimensions of manifold gas pipelines. The cost incurred was $18987 (INR 854483). For purposes of costing, all outlets cost the same, (total outlets was 1609) and taken as such for costing.

Annual cost of manifold including the accessories ($19339.4) as well as the manifold pipelines (with ten percent depreciation) was $38326.8 (INR 1,724,699)(Table-1)

Operating Cost

Building maintenance cost: Cost index was deduced to be $77.2 (INR 3502) per sq mtr. (CPWD memorandum).The annual maintenance cost (Area of the manifold x Maintenance per sq. mtr) was calculated to be $9,159.6 (INR 412,185)

Equipment Maintenance Cost*:* As per the contract, Comprehensive maintenance charges for five yrs and maintenance charge for next five yrs was fixed at $40,000 (INR 18,00,000)**.** Annual maintenance charge was assessed to be $ 4000.

Electricity cost: While the 2 x 7.5 HP Anaesthesia Gas Scavenging System (AGSS) runs for ten working hrs for 300 working days, the 4 X 15 HP Vacuum Supply system pumps and 4 X 15 HP Medical Dry Compressed Air Supply System functions for 24 hrs a day, all 365 days in an year However, only one pump in each works at a time. The total annual electricity cost for manifold was calculated to be $ 31918.3 (INR 14,36,325) of which 94% can be attributed to machinery and equipment $30115 (INR 3,55,175)while only six percent [$1803.3 (INR81,150)] is due to electrical cost of fixtures and fittings .

Medical Gases: Liquid Oxygen:-Total cost for liquid Oxygen (Rate/kg=Rs 6.86/-) for the duration was found to be $ 124402**.**4 **(**INR 55,98,112/-). The 3 months consumption of manifold gases in cylinders along with liquid oxygen the total annual cost of Medical gases is $149,245 (INR 67,16,044) (table 2)

Pump-Oil: Annual cost for 15 gallons of pump oil was $1,883.7 (INR 84,768)

Human Resource: The total Annual Expenditure on salaries of Technical Assistant (01), Operation Theatre Technician (05) Hospital Attendant (05) was $ 65,094 (INR 29,29,248).

Thus the total annual cost of manifold services at the hospital is $ 333,675.6 (INR 1,50,15,404). The daily cost amount to $ 914.17 (INR 41,138). Considering manifold terminal unit the annual cost per outlet was calculated to be $ 207.3 (INR 9332) per year and $0.56 (INR 25.56) per day. The annual and daily cost per bed was Rs $319.3 (INR14368) and 0.876 (INR 39.36) respectively.

IV. DISCUSSION

Since the time of inception of the MGPS in the hospital in 1976, vast changes have occurred not only in the number of beds, but also of facilities such as Operation Theatres(OTs) and Intensive Care Units(ICUs) as well as the role of

manifold services. Further, standard guidelines for planning of manifold services have not been universally adhered to, resulting in occasional duplication and retrofitting. In addition, haphazard growth of the hospital resulting from increasing patient load and rapid medical advances as well as subsequent renovations makes accurate assessment based on these findings for a new, similar facility, difficult. However, despite these drawbacks, a percentage breakup of the costing reveals several interesting observations. While capital cost is 27%, nearly 2/3rd of the expenses (73%) is operating cost, thus making manifold an expensive service to run. Nearly 35% of the expenditure is due liquid oxygen, an operational cost, therefore any new facility must consider this fact while installation of a Liquid Oxygen tank. Most recent manifold facilities are largely automated. Automation of manifold services could help in saving on manpower, the next largest chunk of operational cost (19%).(figure-1)

Few scientific costing studies have been conducted exclusively on manifold services in the Indian context. In our study, daily cost of manifold per bed was $0.876 (INR 39.36). A recent(2010) costing study of the inpatient services of a 200 bedded tertiary level Trauma Centre revealed the cost of manifold services to be $1.93 (INR 86.88) bed/day.[6] The difference may be attributed to the fact the services were entirely outsourced at that facility and a trauma centre would have a larger operational cost per bed. Another study conducted in 1998 to assess the costing of inpatient services estimated total fixed and variable cost on manifold services to be $ 10473 (INR 471,301)[7]. The author calculated the total cost as $349.1/day (as against $ 914.17 in our study; a difference attributable to inflation) and total cost per patient as $ 0.40 (INR18.16) per day. A Costing study carried out in a 425 bedded tertiary facility in India in 1994 revealed that the hospital spends 1.3 cents (INR 0.59) on manifold per patient per day[8]. The study being nearly 15 years earlier the expenditure on manifold per day was $1.9 (INR Rs. 85.5). Besides inflation, it is possible that the disparity in findings is because of the fewer number of beds in the latter case.

V CONCLUSION

This study was undertaken to analyse the costing of manifold services in a large, multispecialty, tertiary care, public sector hospital in India using traditional costing method. The total annual cost of manifold services at the hospital was calculated to be $ 333,675.6 (INR 1,50,15,404). The daily cost incurred due to manifold was $ 914.17 (INR 41,138). Considering manifold terminal unit as the base, the annual cost per outlet was calculated to be $ 207.3 (INR 9332) per year and $0.56 (INR 25.56) per day. Per bed costing is important as design considerations and facility planning are based on a per bed scale. The annual cost per bed was deduced to be $319.3 (INR14368) and the daily cost of manifold per bed was $0.876 (INR 39.36).This expenditure is especially significant since 73% are operational costs.

In a resource constraint country such as India, greater rigour needs to be applied while planning a crucial yet cost intensive support services such as a manifold system with a diligent focus on cost analysis. Future studies may analyse costing from the perspective of the level and extent of automation so that cost containment may be applied.

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TABLE 1 COSTING OF MANIFOLD ITEMS

Sr.No.	**Total cost of various manifold items**			
	Item	***Quantity or length***	***Rate in Rs/Unit***	***Cost in Rs***
1	Copper pipe 11mm	360 mtr	Rs250/mtr	90,000/-
2	Copper pipe 12mm	1824 mtr	Rs 250/mtr	4,56,000/-
3	Copper pipe 15mm	10009 mtr	Rs 350/mtr	35,03,150/-
4	Copper pipe 22mm	6607 mtr	Rs 520/mtr	3435640/-
5	Copper pipe 42mm	670 mtr	Rs 750/mtr	50,25,00/-
6	Copper pipe 54mm	134 mtr	Rs 1120/ mtr	150080/-
7	Imported Outlets	1609 Nos.	Rs 4800 each	7723200/-
8	Imported Probes	213 Nos.	Rs 850 each	181050/-
9	BPC Adaptor	144 Nos.	Rs 250 each	36000/-
10	Clip Shaddle	3653 Nos.	Rs 45 each	1,64,385/-
11	Area Alarm Panel	04 Nos.	Rs 20,000 each	80,000/-
12	Valve Box	05 Nos.	Rs 7,500 each	37,500/-
13	Hose barb	33 Nos.	Rs 100 each	3,300/-
14	MS Box	52 Nos.	Rs 500 each	26,000/-
15	Latch Valve with cover plates	03 Nos.	Rs 1950 each	5850/-
16	Isolation Valve 15mm	13 Nos.	Rs 1250 each	16250/-
17	Isolation Valve 22mm	06 Nos.	Rs 1650 each	9900/-
18	Isolation Valve 28 mm	01 Nos.	Rs 2100 each	2100/-
19	Isolation Valve 42 mm	01 Nos.	Rs 2800 each	2800/-
TOTAL EXPENDITURE ON MANIFOLD INCUDING 5% VAT				**Rs 1,72,46,990/-**
COST INCLUDING 10% DEPRECIATION ON THE ITEMS				**Rs 17,24,699/-**

TABLE 2 COSTING OF MEDICAL GASES

Sr. No.	**Cost incurred due to consumption of various types of medical gases**			
	Type of cylinder	***Consumption in 3 months***	***Rate/ unit Rs***	***Cost (US $)***
1.	D Type	2660 cylinders	13.71/ m^3	854
2.	B Type	794 cylinders	37.00/ cylinder	652.8
3.	A Type	138 cylinders	27.00/ cylinder	82.8
4.	N_2O Bulk	18,22,760 ltrs	86.00/ 1000 ltrs	3483.3
5.	N_2O small	71310 ltrs	91/ 1000 ltrs	144.2
6.	CO_2 cylinder	830 kgs	43/ kg	793
7.	Aviator breathing O_2	18 Cylinders	500/ Cylinder	200
Total cost of medical gases in cylinder for 3 months				**$ 6210.1 (INR 279483)**
Annual cost of Medical gases in cylinders -				**Rs 11,17,932/-**
Annual liquid oxygen cost				**Rs 55,98,112/-**
Total annual cost of manifold gases				**Rs 67,16,044/-**

TABLE 3 COST SUMMARY OF MANIFOLD

SERVICES

Sr. No.	**Total annual cost and percentage component of cost centres**		
	Item	**Annual Cost (US $)**	**Percentage of total cost**
1	Building cost	834.4	8.1%
2	Building Maintenance	9159.6	2.7%
3	Electricity	31918.3	8.5%
4	Equipment	32541	8.7 %
5	Annual maintenance cost	4000	1.1%
6.	Cylinders	673.1	0.2 %
7.	Manifold pipelines	18987	5.2 %
8	Manifold accessories	19339.4	5.1 %
9	**Manpower**	**65094**	**18.5%**
10.	**Liquid Oxygen**	**124402.4**	**35.3%**
11.	Medical Gases	24843	6.1%
12.	Vacuum pump-oil	1883.4	0.5%
Annual Cost of Manifold Services		**$333,675.6 (INR 1,50,15,404)**	**100%**

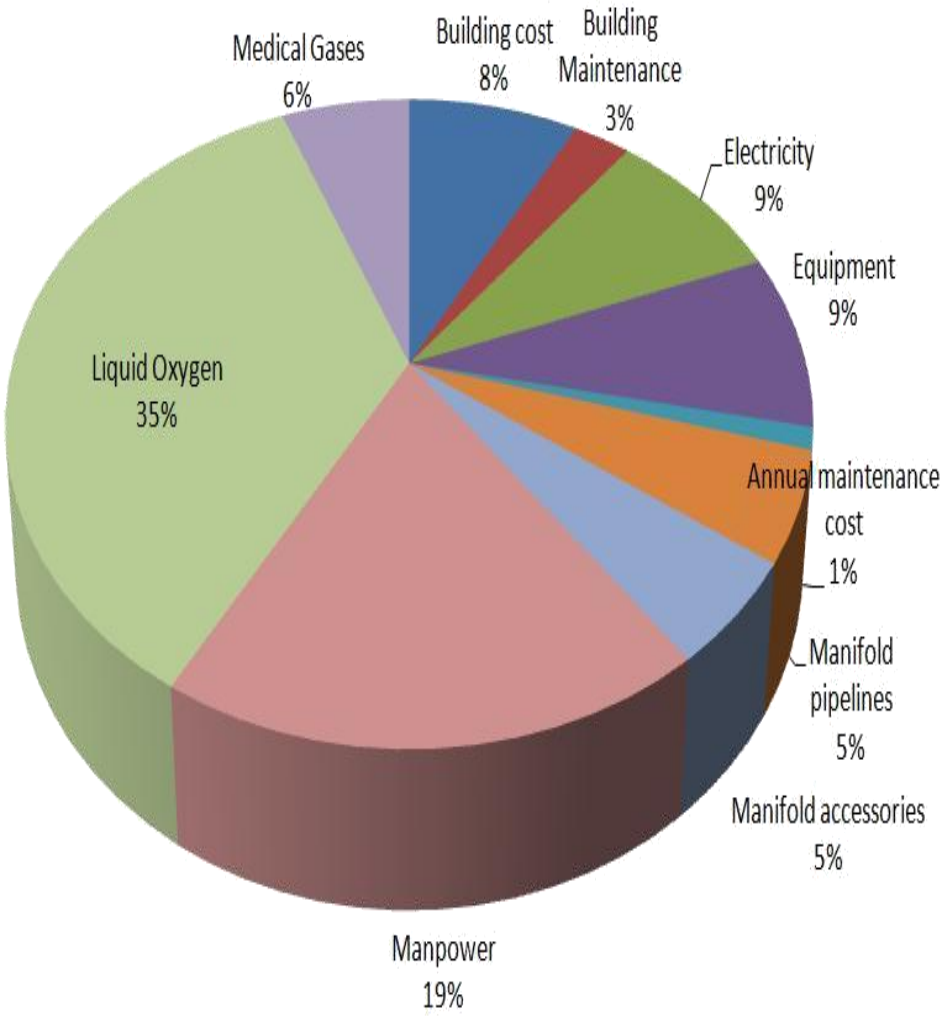

Figure 1 Percentage distribution of cost centres for manifold services