



Review Article

## Insights into Equipment Planning of a 250-Bed Hospital Project

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### ABSTRACT

Too often, a hospital neglects to plan on the purchase of medical equipment. The purchasing process is done on an ad-hoc basis, at the last minute, not based on what the hospital's real needs, and is approved based on who shouts the loudest or is the most influential in the hospital. In this hour, aim is "What should be done to buy the most suitable equipment, for the lowest price, for the right reasons at the right time." Enormous costs involved in research and development has greatly inflated selling costs. It has also introduced a dangerous trend of reducing the functioning life of equipment. Therefore, it is becoming increasingly important to manage medical equipment to contain costs, and yet able to improve efficiency, quality and performance from the equipment that you use. In the excitement of buying new equipment the specialist loses the sight of the needs, costs and likely constraints of maintaining such equipment. This article deals with the best practices in equipment planning. A 250-bed hospital with all basic specialties would require 45 crores for equipment alone. There is need for planning so that new technology can be introduced, co-ordinate purchase, and it helps making process transparent, accountable objectives and it will actually save money too.

The key mantra to beat the above practices is to create a sense of anticipation while training a hospital manager and ensuring adequate safeguards measures prior to the procurement. Efficient Manager needs to play a balancing role between the limited resources of an organization, temerity of the specialist to procure equipment and ground realities of its uses.

**Keywords:** Medical projects, Medical equipment planning, Financial planning of equipment, Maintenance of equipment.

### INTRODUCTION

Hospital, a healthcare delivery agency, is most affected by the changing paradigm of medical technology. Hospital equipment, specialty of new generation has

got immense role in advancement of modern medical technology.

Medical equipment is designed to aid in the diagnosis, monitoring or treatment of medical conditions. They comprise major asset of the health care industry

characterized by wide range, variety and high rate of obsolescence. Medical equipments are very expensive and make about a third to half of total project cost. The use of medical equipment can influence the quality of care and can also create risks for patients and for staff. The proper use of medical technology increasingly determines the effective provision of health care. No other industry uses such a wide range of technology for its operational efficiency.

Facilities management is a strategic function and makes a positive contribution to business growth and organization success. This is a diverse profession whose main aim is to provide quality environments, which are fit for the purpose designed for. It also involves a constant balancing act between the competing pressures of time, cost and quality (Andrew and Michael, 2007). [1] Medical equipment management involves essential activities which ensure that equipment is effectively planned and budgeted for, procured, and operated etc. Human factors engineering is used to influence medical device procurement decisions in hospitals. The process ensures that the safest, most efficient and effective devices are purchased. Human factors engineering is frequently being cited as an important method to reduce medical error and adverse events and to increase patient safety, when it is applied to the design and evaluation of medical devices. [2] Medical Equipment could be viewed as component of healthcare technologies, which has improved the quality of life & state of health. Resources are limited for any hospital. The health industry all over the world today is going into a period of "Health care compression"- Treating more patients with fewer buildings with fewer employees on aging equipment with declining budget. Increasing dependence of medical professionals on equipment, both for diagnosis and treatment, demands their

availability at all times through a comprehensive and responsive engineering support. In modern hospital, the equipment cost is around 40% of the total project cost – 50% of which is invested into the medical equipment and 50% is invested on mechanical & electrical installations.

According to an A T Kearney study, private sector will pump in about Rs 25,000 crore to Rs 40,000 crore in the healthcare sector in the next 5-6 years. Philips Medical Systems, senior director and business head (India, Bangladesh, Sri Lanka and Nepal), Anjan Bose adds, "With the healthcare delivery boom, the medical equipment industry including small devices, which will grow between 15 % and 20% in 1-2 years' time from the current 10%." Wockhardt Hospitals MD Vishal Bali told ET, "The entire industry is focusing on super speciality and it has become imperative to increase investment in equipment to get the best technology. Indian hospitals today have the state-of-the-art technology and about 30-35 % of the investment in a new hospital goes in procuring equipment." As super specialisation becomes a norm in the Indian corporate healthcare industry and companies pump in big money, the medical equipment industry is set for boom time. Indian corporate hospitals are now acquiring state-of-the-art medical equipment. They spend about 35% of their total investment to get the best equipment. [3]

**Aim:**

To plan financial proceedings in procuring, installing medical equipment and optimizing the available funds for setting up a hospital.

Case Study scenario: To plan equipment for a 250-bed tertiary care hospital with specialties in General Medicine, General Surgery, Paediatrics, Obstetrics-Gynaecology, Orthopaedics, ENT, Eye, Cardiology, Interventional Cardiology, Cardio-thoracic department, Neurology-

Neurosurgery, Urology & Radiology. All laboratory, diagnostic equipment required for above said departments is considered in this study. The study says Rs. 45 Crores for equipment management alone is to be planned for a hospital setting in a tier 1 city.

**Objectives:**

1. Identification of the required medical equipment for the hospital.
2. To estimate the cost of required medical equipment.
3. To plan the procurement process, its installation and optimize the available funds.

**Limitations of the study:**

- Assuming that all the following are present - Land, infrastructure, funding, hospital staff, non-medical equipment, Gas supply system, miscellaneous items, ambulance facility, Other engineering facilities like electrical, plumbing, sewage, BMW, Air conditioning unit.
- Expecting the patient load in the hospital appropriate for the full utilization of the medical equipment.
- No refurbished equipment used. All costs were calculated for new machines.
- All cost of equipment is approximate value at the time of inception of study period, subject to change based on market conditions.
- All cost includes freight, license, insurance of the equipment, custom duty, excise duty, import Duty, Octroi, all taxes.
- Procurement procedure from technical specification to procurement are decided by the committee consisting of user department, finance, purchase, biomedical engineer, hospital administrator, Medical

superintendent and representative from board of director.

- For site preparation an architect and civil engineer views being considered, based on theoretical knowledge.

**MATERIALS & METHODS**

- 1) Standard guidelines used to identify the facility required and then associated medical equipment can be listed.
- 2) Existing data from a medical college teaching hospital was used as reference from Biomedical Department, Finance Department, and Purchase Department.
- 3) Costing of medical equipment (Main Equipment + Installation + user training)
- 4) Planning Tools - PERT, CPM, Gantt chart using software.

**RESULTS**

Bureau of Indian Standards (1994) has recommended that while planning for equipment the selection of the equipment should be based on the following steps:

1. Need of the hospital
2. Budget or available fund
3. Optimum utilization
4. Maintenance of the equipment
5. Manpower development & training staff
6. Spare parts management
7. Performance and utilization evaluation

For planning the equipment, bed distribution of the hospital is taken into consideration (shown in Table 1) based on the morbidity indicators (medical charge). Based on this, the medical equipment is divided department-wise and its costing is being done. <sup>[4]</sup>

**Table 1: Bed distribution of the hospital (approximated)**

Department	Beds	Total %
General Ward	30	12
Semi General ward (screen partition)	48	19.2
Semi Private (1 Room with 3 Beds)	30	12
OBG/Gyn Ward	9	3.6
Paediatric Ward	10	4
Semi Special Non A/c (1 Room 2 Beds)	10	4
Semi Special A/c (1 Room 2 Beds)	20	8
Deluxe Non A/c	10	4
Deluxe	20	8
Super Deluxe	6	2.4
ICU		
Main ICU (Medicine)	10	4
SICU	5	2
Cardiac ICU	10	4
OB/ Gyn	5	2
PICU	5	2
NICU	8	3.2
Neuro ICU	4	1.6
Nephro	3	1.2
Private ICU	2	0.8
Day Care	5	2
	250	100
Casualty	5	
Dialysis	10	
Recovery Room (Pre-op & Post op) Trolley	5	
	20	

## STEPS IN PROCUREMENT & INSTALLATION OF EQUIPMENT:

The medical equipment life cycle includes the tendering and commissioning of new equipment in conjunction with the end users, the training and education of all devices for staff on their operation and application, performing the necessary preventive maintenance, conducting repairs and finally device disposal, at which point the life cycle begins again (Andreas et al, 2000). [5] Figure 1 shows a cycle of activities in the life of equipment under equipment management.

All phases of the medical equipment life-cycle are of great interest in the WHO European Region: the research and development phase at manufacturers in industrialized countries and the clinical phase in all countries. The clinical life-cycle phase of the medical equipment takes place within a health facility and entails the following processes: [6]



**Figure 1: Equipment Life Cycle. (Andreas et al, 2000).**

### 1. Technical specification of all the medical equipment:

Once need is established, the great emphasis should be given on selection of the equipment. The criteria to be kept in mind – high technology equipment once installed remains idle due to many reasons

which are not considered at the time of selection of the equipment.

The other criteria, which can be applied in the selection of equipment is VED and HML analysis. VED- It is a need-based selection. Selection is based on whether the equipment is vital, essential or desirable. Decision is taken on the basis of use of the equipment for that particular situation

HML- It is based on the cost of the equipment. Purchase based on fund available. High, Medium, and Low equipment are purchased on the necessity and availability of funds. Detailed specification is prepared using unambiguous language.

## **2. Finalize on the technical specification of all the equipment:**

The final choice of the equipment and facility to be used depends upon:

- All the user department inputs should be considered.
- What is available and what can be made available – technological feasibility constraints.
- What is economically reasonable - The design of the process, the quality of its output and its operating efficiency will affect the amount of investment capital that can be attracted.

## **3. Advertise / Contact all the respective vendors and call/Receipt of Quotation**

List of suppliers, their address, capabilities, past experience and reputation should be used to call and contact all the respective vendors for the quotation.

Enquiries can be:

- a) Directly to the vendors

- b) Quotation can be invited by letters and by advertising

- c) Public Advertisement in the reputed newspapers

- d) Global tenders can be invited

Tender terms & conditions, supply period, time limit etc. must be clearly mentioned.

## **4. Demonstration / Quotation of the equipment from the vendors**

Sealed envelopes/ confidential E-mail document containing technical specification, offers, price and other financial details can be received.

Vendors can also demonstrate their technology.

## **5. Vendor Analysis – Finalizing on the vendor**

Comparative statement should be made mentioning following details:

- a) Name of the supplier
- b) Details of specification
- c) Basic price
- d) Taxes, levies, installation charges
- e) Freight and insurance charges
- f) Payment terms
- g) Delivery period
- h) Guarantee/warranty on spares and period
- i) After sale service-terms and condition
- j) Any other conditions

All responsive offers that are fulfilling the needs are short listed.

## **6. Negotiation – finance, maintenance services, spare parts, accessories**

Offers are discussed with the committee and necessary negotiation are carried out by the committee with the supplier

- a) Asking for clarification
- b) Cost reduction
- c) Bearing the cost of site preparation
- d) Training of the personnel etc.

## **7. Final Quote / Invoice**

After satisfactory discussion & demonstration and confirmation final invoice is sent to the vendor and order is placed.

#### **8. Payment policy**

If the equipment is indigenous, payment done is on negotiated payment policy with respective vendor.

If the equipment is to be imported, following documents are required:

- a) License – If the item is included under open general license (OGL), specific import license is not required. If the item is not included in OGL, specific import license is required
- b) Product Literature and proforma invoice: Product Literature and proforma invoice mentioning price, cost-insurance-freight (CIF), free on board (FOB), mode of transport-air, ship need to be obtained.
- c) Custom duty exemption: It is necessary to verify whether the item to be imported is included in the published exemption list. Exemption is usually granted to
  - i. Government and hospitals and approved research institutes
  - ii. Life-saving items
  - iii. Gift on board to charitable , non-profitable organization
  - iv. Re-import for repaired item. If the item or the hospital are not having , custom duty exemption ‘not manufactured in India Certificate(NMIC)’ then the custom duty exemption certificate need to be obtained
  - v. For minor imports bank draft is issued to supplier. For major letter of credit is issued

#### **9. Procurement / Delivery of the Medical Equipment**

Vendor should arrange for the appropriate mode of transport and confirm for proper packaging. On Delivery, Biomedical Engineer verifies all the Documents as per the protocol of the hospital and verifies the condition machine for any external damages. The company/vendor is informed regarding the procurement of the equipment who then further arranges for the installation of the equipment.

#### **10. Installation of the Medical Equipment**

This is done by the Biomedical Engineer as per the protocol of the hospital

- a) Documents are verified
- b) Machine is opened and installed
- c) After satisfactory installation, it is included in the inventory and in relevant registers
- d) Joint demonstration by supplier, user and biomedical engineer is arranged
- e) The item is taken to user department
- f) Bill is certified and forwarded to account department for the prompt payment

**For the radiology equipment installation:** Qualified engineers provide the following during the install process:

- Phase 1- Mechanical installation (assembly, positioning, connection to utilities)
- Phase 2- Calibration and testing to AERB/BARC standards.
- Registration under PNDT Act, for ultrasound machine
- Completed desired documentation

For convenience of planning, the medical equipment are divided into three grades depending on the time required for site preparation, procurement and installation, shown in Table 2.



**Table 2: Medical Equipment divided into grades depending on the time required for site preparation, procurement and installation**

Grade I - equipment	Requires site preparation and long time for procurement and installation like Operation theatre Equipment and Radiology Equipment
Grade II - equipment	Requires Considerable site preparation but less installation time like all ICU, all Laboratory, Blood Bank, CSSD, Casualty, Ambulance, Day Care, Dialysis equipment
Grade III - equipment	Requires no site preparation and can immediately be installed like OPD, Wards, Rehabilitation equipment

### 11. User Training

User training is arranged for all the respective technician and staff for all the medical equipment in their respective departments by the qualified engineers from the company.

**Table 3: Table showing costs incurred on capital investment (Capex):**

Departments	Cost
Radiology	18,93,00,000
OT	10,54,96,000
All ICU	8,30,69,000
NICU,PICU	2,17,29,000
CSSD	1,01,88,100
Day Care/ Dialysis	1,46,52,000
Casualty	36,30,000
Ambulance	3,60,000
OPD	50,10,800
Wards	83,33,000
Rehabilitation	44,04,532
Grand Total	44,61,72,432

### Equipment financial planning:

Financial planning consist of Capital expenditure (capex) and working expenditure (workex). The Radiology department and Operation theatre consists major part of the capex which is approximately 30 Crores, as compared to other equipment. The costs that a 250-bed hospital has to spend on equipment are mentioned in Table 3, and an example of equipment considered for radiology department is mentioned in Table 4, for the research purpose.

Department	Cost
Clinical Laboratory, Microbiology, Biochemistry, Pathology	74,97,000
Blood Bank	1,08,85,000
Total	1,83,82,000

**Table 4: An illustration of Radiology equipment considered for the project:\***

Equipment	QTY	unit cost	Manufacturer	
<i>Radiology &amp; Imaging</i>				
X Ray- 500 mA With Motorised Table +Radiology Accessories, Lead Apron, X-ray Viewer	1	17,00,000	17,00,000	GE, Philips,Siemens
Mobile Xray Machine (60ma-HF)	2	300,000	600,000	
Color Doppler Ultrasound Machine With 4 Probes: Abdomen, Paediatric, Soft Parts And Intra-cavitary Ultra Sonogram (Obs&Gyne.)	1	35,00,000	35,00,000	
Ultra Sound Machine- Portable (Radiology)	1	15,00,000	15,00,000	
CT Spiral (128 Slices)	1	9,20,00,000	9,20,00,000	
2-D Echo	1	20,00,000	20,00,000	AGFA
DR (Digital Radiography) System	1	1,50,00,000	1,50,00,000	
CR Reader + Printer	1	30,00,000	30,00,000	
1000mA X-ray With Fluoroscopy	1	70,00,000	70,00,000	GE, Philips,Siemens
Mammography	1	30,00,000	30,00,000	
Cath-lab Unit	1	5,00,00,000	5,00,00,000	
Integrated PACS With RIS And HIS(Contain LIS)		1,00,00,000	1,00,00,000	
			18,93,00,000	

\* For illustrations of any other department's equipment readers are requested to write to corresponding author.

All laboratory and blood bank equipments are purchased on Lease Rental basis, because of following advantages:

- A lease is a contractual agreement between a lessee and lessor. The agreement establishes that the lessee has the right to use an asset and in

return must make periodic payments to the lessor. The lessor is either the asset's manufacturer or an independent leasing company.

- **SAVING OF CAPITAL:** Leasing covers the full cost of the equipment used in the business by providing 100% finance. The lessee is not to provide or pay any margin to manufacturer, lessor or lender money, as there is no down payment. In this way the saving in capital or financial resources can be used for other productive purposes e.g. purchase of inventories.
- **FLEXIBILITY AND CONVENIENCE:** The lease agreement can be tailor-made in respect of lease period and lease rentals according to the convenience and requirements of all lessees.
- **PLANNING CASH FLOWS:** Leasing enables the lessee to plan its cash flows properly. The rentals can be paid out of the cash coming into the business from the use of the same assets.
- **IMPROVEMENT IN LIQUIDITY:** Leasing enables the lessee to improve their liquidity position by

adopting the sale and lease back technique.

- **TAX BENEFITS:** Lease rental is 100% tax deductible, meaning that all payments made for equipment are written off against the tax bill. Lease rentals are considered as an operating cost, which means that it is often possible to deduct them from taxable profits (as a trading expense). However, it should be always checked that the equipment you are buying is eligible for tax benefits, before agreeing to a contract. If the business pays no or minimal taxes, then some leasing companies will claim the capital allowance on your behalf, and lower the leasing costs accordingly.

**Cash flow planning:**

With the above infrastructure invested in the equipment for a hospital project, the cash outflows that can be expected in the first half year of commissioning is as shown in Table 5.

**Table 5: Cash Outflows for medical equipment:**

Months	Grade I – Equipment	Grade II – Equipment	Grade III – Equipment
January			
February	Approximately 6 Crs (20% of PO value will be released as advance payments by the end of February)		
March		Approximately 3.4 Crs (25% will be released as advance payments by the end of March)	
April			Approx. 45 Lacs 25% will be released in mid of April
May	Approx. 21 Crs (70% of PO value will be released as advance on delivery by start of May)	Approx. 8.6Crs (65% will be released as advance payments by mid of May, amounting)	Approx. 1.2 Crs 70% will be released in the end of May
June	Approx 2.9 Crs (Balance payments will be released in the end of June on installation and acceptance)	Approx. 1.4 Crs (Balance payments will be released in the mid of June)	Approx. 9 Lacs Balance payments will be released in the mid of June



**Funds planning:**

The surplus cash determined on receipt of the first installment:

- No out flow in the month of January, hence the same can be invested in short-term avenues
- February end outflow will be 6 crs, ensure cash availability at that juncture

- Month of March outflow will be 3.4 crs.
- Thereby a surplus of 5.6 crs in the first installment.

Funds which are rated by Crisil as rank-1 which specifies good fundamentals are chosen for the investment.

<p><b>A. Agency of Maintenance</b>  a. In-house workshop  b. Manufacturer/authorized dealer  c. Third party  d. Full time dedicated Engineer</p>	<p><b>B. Types/systems of Maintenance</b>  a. Preventive (regular/Planned)  b. Breakdown  c. Corrective  d. Productive  e. Predictive  f. Emergency  g. Shutdown</p>
<p><b>C. Methods of Maintenance</b></p> <ul style="list-style-type: none"> <li>• In house maintenance services <ul style="list-style-type: none"> <li>➤ Unit Maintenance system</li> <li>➤ Maintenance by specialized crew</li> </ul> </li> <li>• Maintenance by outside agency <ul style="list-style-type: none"> <li>☐ Maintenance contract- Preventive and Breakdown <ul style="list-style-type: none"> <li>➤ Comprehensive (with spares)</li> <li>➤ Non Comprehensive (without spares)</li> </ul> </li> <li>☐ Maintenance Contract – Breakdown only <ul style="list-style-type: none"> <li>➤ Comprehensive (with spares)</li> <li>➤ Non Comprehensive (without spares)</li> </ul> </li> <li>☐ No Contract as and when required basis – Breakdown only <ul style="list-style-type: none"> <li>➤ Comprehensive (with spares)</li> <li>➤ Non Comprehensive (without spares)</li> </ul> </li> </ul> </li> </ul>	<p><b>D. Schedule of maintenance</b>  a. Planned Preventive- running, shutdown  b. Unplanned corrective breakdown emergency</p>

Classification of Equipment maintenance program: [7] Shown in Box above as Figure 2.

**MAINTENANCE OF THE EQUIPMENT**

Healthcare equipment that is out of order quickly leads to a decline in demand, which will in turn reduce the income and quality of services of the health facilities. The hospital may lose clients if, for example, it becomes known that malfunctioning of medical equipment, for instance if sterilization equipment may endanger the health of the patients. Similarly, patients will avoid visiting health facilities which do not possess functioning diagnostic equipment. The maintenance managers are required to accomplish the maintenance for medical equipment in a timely, economical, and professional manner. Due to ever-changing operational requirements and conditions, effective

maintenance management requires leadership, planning, organization, assignment of responsibilities, functions and resources, direction, and flexibility. Management of resources (tools, test equipment, standby equipment, spare parts, time, and personnel) should be a daily concern. All resources must be present in sufficient quantity when needed to accomplish the maintenance objective. [5] Bureau of Indian Standard (BIS, 1994) has defined the equipment maintenance as the “combination of all the electrical and administrative actions, including supervision actions intended to retain an item, or restore it to a state at which it can perform required function” Main Components of Equipment maintenance system are:

1. Maintenance Policy
2. Importance and objectives of maintenance
3. Maintenance programs
4. Cost of the Maintenance
5. Precautions for servicing and safety use of equipment
6. Spare parts of management
7. Training and education
8. Legal and ethical aspects of equipment maintenance
9. Responsibility of maintenance
10. Maintaining the records of the equipment maintenance
11. Equipment operated at clinical/research field

## CONCLUSION

Medical equipment used for diagnostic, monitoring and therapeutic purposes is a key component of medical treatment. Managing the equipment is one of the most important functions of hospital for continuous, uninterrupted and quality services.

It is emphasized that the state of art technology is what gives the hospital the cutting edge in maintaining the treatment standards as well as the advantage in meeting the exciting cutthroat competition.

Proper management of equipment starting from selection, purchase, installation, use and maintenance are important for ensuring continued readiness of the service. In addition, within the meager Medical equipment budget allotted, the proportion of funds for repair and maintenance is low, compounding the management problems. Most health managers, doctors and nurses in developing countries are not familiar with the basic concepts of equipment management. After being procured, the equipment is installed at respective locations and appropriately documented with sufficient user training.

Hence the proper financial planning of medical equipment with project management and financial tools, efficient medical equipment management can be achieved leading to proper use of funds allotted and revenue can be generated.

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