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Certificate Course in

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Module 5: Healthcare technology - Regulatory, policy and Practical aspects

Selection of technology in healthcare. Economics vs outcomes

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Selection of technology in healthcare. Economics vs outcomes

Introduction

We have learnt in the previous sub-module about healthcare technology assessment (HTA). We know that HTA plays a major part in evidence-based decision-making. We know that without good evidence, the uptake and diffusion of healthcare technologies is likely to be influenced by a range of social, financial and institutional factors that could result in suboptimal health outcomes and inefficient use of available resources.

We have also learnt that healthcare technology assessment utilizes ethical, socially relevant, legally compliant, cost effective decision making concepts that are evidence based. We have learnt cost minimization, cost utility, cost benefit and cost effective analysis as certain tools for healthcare technology assessment.

This sub- module shall continue to expand albeit in a simplistic manner concepts learnt in the previous module and add on certain economic evaluation concepts that should be linked with effective outcomes while arriving at procurement decisions for acquisition of healthcare technology.

Learning Objectives

After completion of this sub - module you should be able to

- Understand the commonly used terminologies like procurement, healthcare technology, economics and outcomes

- Develop a basic understanding of the procurement cycle
- Comprehend the economic concepts that are applicable to healthcare
- Understand the tools for economic evaluation of technology by using simple examples.

Let us begin with Procurement.

Understanding Procurement

Procurement refers to **techniques, structured methods, and means** used to **streamline an organization's procurement process** and **achieve desired results** while **saving cost**, reducing time, and building **win-win supplier relationships**.

To put it simply, the **goal** of procurement is to provide the **right product or service** of the **right quality** from the **right source** at the **right place** at **right time** in the **right quantity** for the **right people** and at the **right price**

Before we move further into the main subject, let us briefly take a look at the **steps involved in procurement**. Any procurement process whether it is e procurement or otherwise, the steps by and large remain the same. They commence with planning for the healthcare technology by undertaking the need assessment that is dependent upon the following factors

- **Social relevance** ie whether the technology being procured is socially relevant and based upon the needs of the society. For eg in this pandemic of COVID 19, vaccine is the socially relevant technology which is the need of the hour.

- **Legally compliant** ie the technology being acquired is in consonance with the legal and statutory requirements of the state or the country. For eg, In India any radiotherapy equipment will have to be compliant with the requirements of Atomic Energy Regulatory Board (AERB)

- **Ethically justifiable** ie the proposed technology is in consonance with the ethical principles in terms of **Beneficence** (For the benefit of the community, **Non-maleficence** (It does not cause harm and is safe)and **Equity** (It can be used without any prejudice to economic, educational and religious or ethnic status .

  For eg The vaccines for COVID 19 have first been subjected to clinical trials to ascertain their efficacy and safety and then are being distributed based upon the needs of the populations ie frontline workers, followed by those who are at greater risk.

- **Effectiveness** ie it meets the established objectives of the healthcare delivery system whether they are related to prevention, health promotion, cure or disability restriction or else reduction of mortality and morbidity

- **Economical ie** it is economical to procure and use and shall not increase price of care in a catastrophic manner.

All these factors are considered in totality before arriving at a decision to procure or acquire a specific technology.

The **other steps involved** in procurement are more logistic oriented than planning oriented but they must figure in the planning so that the technology to be procured is as per established good practices of procurement and take into consideration the specifications of the technology desired, market surveys to check for availability, asking for quotations from different vendors, technical and commercial evaluation of bids received, contract negotiation, placement of supply orders, receipt ,inspection and installation , operation and calibration and maintenance of the procured technology . In addition provisions have to be made for training of the operators in its use as well as preparations for installation, storage etc have also to be catered for in advance.
To summarize, the procurement process consists of the following steps:-

- Planning and need assessment
- Budgeting and Financing
- Market Surveys
- Making of Technical specifications
- Tendering Action or Requesting for Quotations (Technical and Commercial bids)
- Technical and Commercial Bid Evaluation
- Contract Negotiation and Placing of Supply orders
- Contract management and evaluation
- Other aspects are based upon the Healthcare Technology being procured

Diagrammatically the same is depicted in Figure 1 below: (Open Source in Internet)

Figure1: The Procurement Process

Let us now look at what are we trying to procure?! We are basically trying to procure healthcare technology. It may thus be appropriate at this time to define healthcare technology and classify the same.

Understanding healthcare technology

Healthcare technology is defined by the World Health Organization as the "application of **organized knowledge and skills** in the form of **devices, medicines, vaccines, procedures, and systems** developed to solve a health problem and improve quality of lives".

Traditionally healthcare technology can be **classified** as under

- **Therapeutic** that includes Drugs, Devices, Instruments and equipment that are utilized for cure and care purposes

- **Diagnostic** that includes technologies adopted in the diagnostic services like Laboratory, Radiology and several others like ECG, EEG etc

- **Monitoring** that includes devices like various Temperature and BP monitoring devices, cardiac monitors, weighing machines etc

- **Preventive** ie Vaccines etc

- **Information based** ie Electronic Medical or Health records

- **Process** and **Systems** based
  Now we have Digital based technologies, Decision Support systems, Artificial Intelligence, Internet of Things, Telemedicine, Tele Radiology, Tele Pathology etc which are bound to grow and can be related to processes and systems.

Having understood the procurement process and healthcare technology let us move further to ask ourselves some questions before acquisition of healthcare technology

Q 1 Should I buy an Ultrasound /256 slices CT / 3 Tesla MRI machine or should I outsource?!

Q 2 Will my investment in health care technology give me appropriate returns?!

Q 3 What is the cost of one fully vaccinated infant?!

Q 4 What should be the charge of a Laboratory test?!

Q 5 Which is an economically more viable alternative for reducing diarrhoeal mortality? Setting up ORBs or Improving environmental sanitation

Q 6 Should the country invest more in Defence or in Health?

Q 7 Should we invest more in Fertility programmes or in population control programmes ?

You will agree with me that these are relevant questions. What can we do to arrive at answers to these questions?

Well the answer lies in **Economic Evaluation of Healthcare Technology** which is based on the understanding of **Outcomes** to be achieved and concepts of **Economics**.

Understanding Outcomes in Healthcare

In healthcare we expect all or some of the following outcomes from the technology that we use

- Early Diagnosis
- Early Treatment and Return to Productivity
- Reduction in Mortality
- Reduction in Morbidity
- Improvement in Quality Adjusted Life Years
- Disease Prevention
- Health Promotion
- Change in health related behaviour

Understanding Economics

Economics is a science of choice. It is not all about money. It is about the availability of **finite resources** to meet the **infinite needs** and demands of healthcare. Hence choices have to be made which could be amongst **competing alternatives** as given in some of the questions asked above.

Economics is, therefore, the study of how individuals and societies choose to **allocate scarce productive resources** among **competing alternative uses** and to **distribute the products from these uses** among **members of the society**. (World Bank, 2001) Economics relates to **allocative efficiency** in times of **scarcity and** Health economic studies provide information to decision makers for **efficient use of available resources** for **maximizing health benefits.**

Broad concepts of Economics

Some broad concepts of Economics that we shall cover in this sub module and which shall help us in economic evaluation relate to the following:-

- Scarcity, Margin and Utility
- Production function
- Demand
- Externalities
- Cost concepts including Opportunity cost
- Break even analysis
- Cost benefit analysis
- Cost effective analysis

Some of these topics have been covered in great details in your sub module on Healthcare Technology Assessment. These concepts shall just be explained here with some examples.

Concept of Scarcity

The Health resources in terms of human resources(men/ women), money , material , machines, methods, metres (space), minutes (time) and information are scarce and limited whereas the demands for healthcare services are unlimited and are recurring in nature.

Therefore, Choices are to be made to allocate scarce health resources in order to maximize output within available inputs. We must also remember that unlike in other products and services, in healthcare the supply of a new technology will invariably create a demand for the service

The concept of Scarcity is closely linked with the next concept of Margin

Concept of Margin

If Health resources are scarce, one has to be careful about utilization of each and every additional unit of the resources. This is the concept of margin.
Egs – Additional output expected by using additional physician or equipment, Additional investment say in CT scan has to be taken in view of the additional return from the investment .
A marginal change in an economic variable is caused by the smallest possible change in another variable that is expressed as one unit of that variable. Let us now assume that our dialysis facility is working at full capacity. In order to entertain the next additional patient we may have to create additional facility and thus the cost of creating that additional facility will be high and we can in short state that the marginal cost of creating a dialysis facility for an additional patient is high. If we were to consider the marginal cost of the last dialysis performed before reaching full capacity that would be very small

Concept of Utility

Utility is the capacity to satisfy a human need directly or indirectly. It provides a dimension by which to measure the want satisfying capacity of an item, service, equipment and it contributes to the effectiveness of an organization. In health a utility is the measure of preference or value that an individual or society gives to a particular health state. This could be a numeric zero for death and 1 for perfect health.

If we combine the margin and utility concept we come to an important concept of **Law of Diminishing Marginal Utility.** The law simply states that as a consumer

consumes more and more quantities of a specific commodity or a service **utility** from the **successive units** go on **decreasing.**

A simple example : Given the fact that you are hungry then the utility value of the first chappati that you eat is very high but as you at the subsequent chappatis the marginal utility of each chappati as it relates to your hunger keeps on decreasing till it becomes zero. At this point the Total Utility is maximum. Figure 2 denotes the Total Utility and Diminishing marginal utility concept (mu) and Fig 3 shows the relationship that when Total Utility (Tu) is maximum the Marginal Utility is zero.

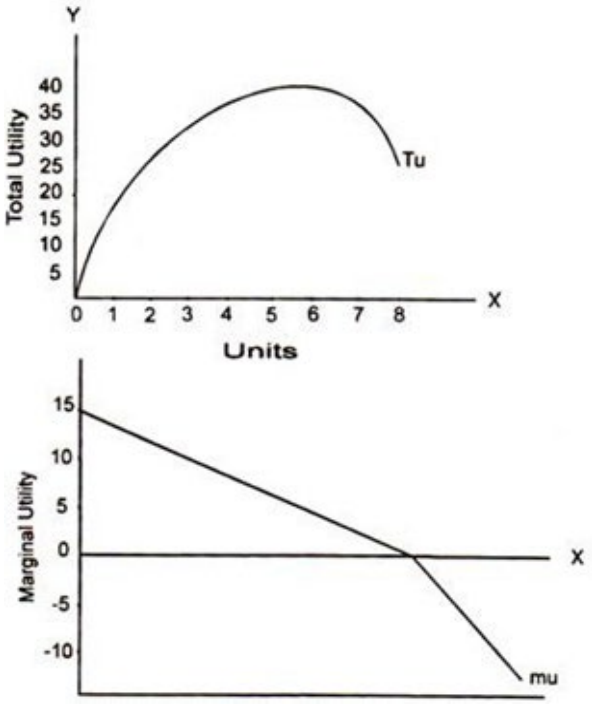

Fig 2: Concept of Total Utility and Law of Diminishing Marginal Utility(Source: Forestrypedia.com)

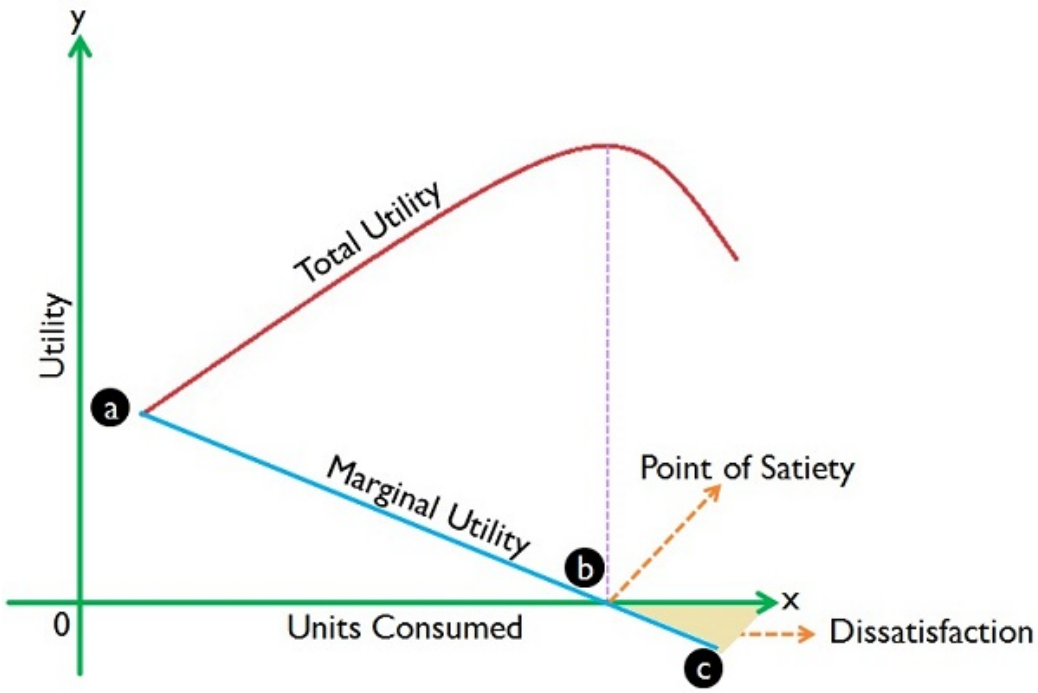

Fig 3: Relationship between Total and Marginal Utility (Source: Forestrypedia.com)

The same thing is applicable to healthcare technology. As we use technology for attaining its specific utility value, the marginal utility shall keep on decreasing till it becomes zero when the total utility will be the maximum. Utilization thereafter will only result in negative utility values. When the marginal utility becomes zero, the concerned health care technology can be weeded out.

Since utility is related to production function, let us understand another concept of Economics that is Production Function

Production Function

This expresses the relationship between the amounts of various inputs used in the production process and the level of output achieved. Production Process in health sector refers to various clinical, nursing and diagnostic processes.

Inputs are in terms of physicians, nurses, diagnostic tools, therapeutic and monitoring equipment etc

Output is expressed in terms of patients seen, admissions, discharges, deaths averted / prevented etc

Production function can give us an understanding of technical, economic and scale of efficiency.

Technical Efficiency deals with the mix of inputs which will produce a given output ie **Given the resources** in the health sector we should be able to obtain **the maximal possible output.** Alternatively while **producing a given output** in the health sector **we should aim at utilizing the minimal possible resources**
For eg , the number of patients that can be vaccinated in a facility depends upon the availability of the medical and nursing staff and the vaccines. If one doctor and two nurse can vaccinate 150 people in one day then it is technically inefficient to vaccinate only 125 people in a given day using the given staff or vaccinating 150 people by using more number of staff

Economic Efficiency deals with **the least cost combination of the inputs** which will produce **the desired output ie** given a **fixed budget** is the **output maximized** or given a **fixed output** is the **total cost minimized.** Using the same eg as above it may be possible to utilize the services of two doctors and one nurse to carry out 150 vaccinations in a day but since doctors will come at a higher cost and the same output can be achieved by deploying one doctor and two nurses where the wages of nurses are less, then the decision becomes economically efficient**.**

The scale of efficiency is another parameter to determine economic and technical efficiency. These may be constant scale, increasing or decreasing scale of efficiency. Let us try and understand this concept with some simple examples.

In **constant returns to scale** if Inputs are increased in equal proportional amounts, the output increases at a constant rate

For eg If physicians time, nursing hours , supplies and equipment and beds are **increased by 10 %** the OPD cases disposed , discharges from the hospitals and health programme results also **increase by 10%**

In **increasing returns to scale** if Inputs are increased in equal proportional amounts, output increases at increasing rate

For eg If physicians time, nursing hours , supplies and equipment and beds are **increased by 10 %** the OPD cases disposed , discharges from the hospitals and health programme results **increase by 15%**

In **decreasing returns to scale** if Inputs are increased in equal proportional amounts, output increases but at **decreasing** rate

For eg If physicians time, nursing hours , supplies and equipment and beds are **increased by 10 %** the OPD cases disposed , discharges from the hospitals and health programme results **increase by 5%**

The Externalities

Any intervention that we undertake will also have certain unintended spillover effects **on** the community. These effects are called externalities. They describe hidden benefits or losses to society of the healthcare technology being utilized and represent the overall community or spillover effect of health care activities or programmes that are not consciously taken into account in production or pricing decisions.

For eg Preventive efforts can reduce expenditure on curative treatment. In the current pandemic , the efforts to vaccinate the population can lead to herd immunity and reduce the cost of Intensive care that are needed to prevent mortality in the population on account of COVID 19. This is beneficial spill over effect.

The loss to the society occurs in terms of suffering and losses incurred due to pollution from unplanned and haphazard industrialization / transportation.

Let us now briefly discuss Costs

The Cost Concept

Cost is a sacrifice that one makes or promises to make in the future to acquire a benefit now or in some point in the future. When this sacrifice can be converted into money or currency terms it is called monetary costs..

These costs can be classified as Direct Costs, Indirect Costs based on direct or indirect relationship to the output being generated. These can be further subdivided into Material, Labour and expenses.

If we want to do the costing of say Intensive care Unit the **direct labour costs** refer to the cost of physicians, nurses providing care, **the direct material costs** refer to use of devices and drugs being used to provide the care and the **direct expenses** relate to cost incurred in transportation of consultants or experts from other organizations or within the organization to provide specific speciality based care.

The **Indirect costs** are also called **overhead**s. In case of Intensive care Unit, the **indirect labour cost** is the cost incurred on housekeeping and security staff, the **indirect material cost** refers to cost involved in providing security and housekeeping equipment and materials and indirect **expenses** refer to cost incurred on electricity and building unit.

The costs can also be defined in terms of their variation with outputs. **Fixed costs** are those which remain fixed over a period of time irrespective of the outputs. For eg if we procure an ultrasound machine for Rs Ten Lakhs inclusive of Comprehensive maintenance for five years, this cost is fixed as it has already incurred whether we do one ultrasounds or we do one thousand ultrasounds and this cost will not be affected . That is why it is called Fixed cost. As we increase the number of ultrasounds done the fixed cost per ultrasound can notionally be expected to come down.

Variable Cost varies with every unit of output. In the above eg if we spend Rs 100 on doing one ultrasound which includes proportional salary to staff, consumption of jelly,

X ray film and stationary, then we will spend Rs 200 on doing two ultrasounds and Rs three hundred on three ultrasounds and so on so forth. Variable Cost unlike Fixed Cost **increases per unit of output.**

To summarize we have the following costs that can be applied to healthcare technology

- **Fixed** : Does not vary with number of outputs
- **Variable** : Varies with the output
- **Direct Costs** : Health care related costs
- **Indirect Costs** : Loss in productivity as a result of illness/death/ & care-givers time
- **Overhead Costs** : Indirect Costs which are shared by more than one cost centres ie electricity, administrative, marketing, rentals, housekeeping, security etc

There is just one another concept of cost and that is the concept of **Opportunity cost** which states that the cost of committing resources for one particular use is the benefits that are foregone by not committing them to their most valued alternative use. **Money enters only notionally as a unit of measurement.** The real cost of a new drug, for example, is the other drugs and / or services that may not be available (either in the health sector or elsewhere)

An Illustration on Cost concept

A diagnostic Lab is presently doing 1000 Hb tests @ Rs 10 per test. Variable Cost (VC) per unit is Rs 5 and the total fixed costs(FC) are Rs 4000.The Lab has now received a contract from the Govt for doing 200 tests @ Rs 8 per test.The execution of this contract will increase fixed cost by Rs 200 .Should the Lab take on this contract? Will it be beneficial to the Lab?

The Solution

The existing situation

FC = Rs 4000

Total number of units of tests 1000

VC = Rs 5 per test = 5 x 1000 = Rs 5000.

Total Costs = FC + VC = 4000 + 5000 = Rs 9000

Total Revenue = Selling price per unit x Total number of tests

TR = 10 x 1000 = Rs 10,000

Current Profit = Rs 10,000 – Rs 9000 = Rs 1000

Proposed Situation

FC = Rs 4000+ Rs 200 = Rs 4200

Total number of units of tests 1000+ 200 = 1200

VC = Rs 5 per test = 5 x 1200 = Rs 6000.

Total Costs = FC + VC = 4200 + 6000 = Rs 10200

Total Revenue = Selling price per unit x Total number of tests

TR = 10 x 1000 + 8x 200 = Rs 11,600

Current Profit = Rs 11,600 – Rs 10,200 = Rs 1400

The Laboratory should go for the contract as it shall make additional profit of Rs 400 (Rs 1400- Rs 1000)

Let us now visit another concept of Economics called Break Even Analysis

Breakeven point is the point where there is no profit and no loss from the investment made. This means that at this point the Total Costs are equal to Total revenue. Let us derive the breakeven point formula just for the sake of ease of understanding the concept. You may forget this derivation and only remember the formula but understanding the derivation will help you to remember the formula.

The formula derivation

The Total costs (TC) involved in say buying an ultra sound machine are the Fixed Cost (FC) and the variable Cost per Unit (VC per unit) multiplied by the Quantity(Q units expected to be produced**. In short TC = FC + VC per unit x Q**

The Total Revenue (TR) expected from the production of Q ultrasounds is Selling Price per Unit (SP per unit) multiplied by the Quantity Q. In short TR = SP/unit x Q

Break Even point occurs when **Total Revenue(TR) = Total Cost(TC)**

Substituting the breakup of Total cost and Total revenue we arrive at the equation

TR = TC

SP per unit x Q = FC + VC per unit x Q

SP per unit x Q – VC/ unit x Q = FC

Q (SP per unit – VC per unit) = FC

Q = FC / SP per unit – VC per unit

SP per unit – VC per unit is called **Contribution per unit**

Hence the Quantity of output at which a particular healthcare technology will recover its costs is the **Fixed Cost of the technology divided by the contribution per unit of that technology.**

You are just required to remember the formula and not the derivation thereof.

The graphical representation of breakeven analysis is depicted in figure 4. You can ascertain from the figure that the point of intersection at which total sales and total cost lines intersect is the breakeven point and the angle formed by this intersection is called the angle of incidence.

Any output beyond the breakeven point is profitable and is referred to as the safety margin for the technology. If a healthcare technology breaks even within two third or 67 % time frame of its economical life it is said to be an economically viable technology and is worth investing in the same.

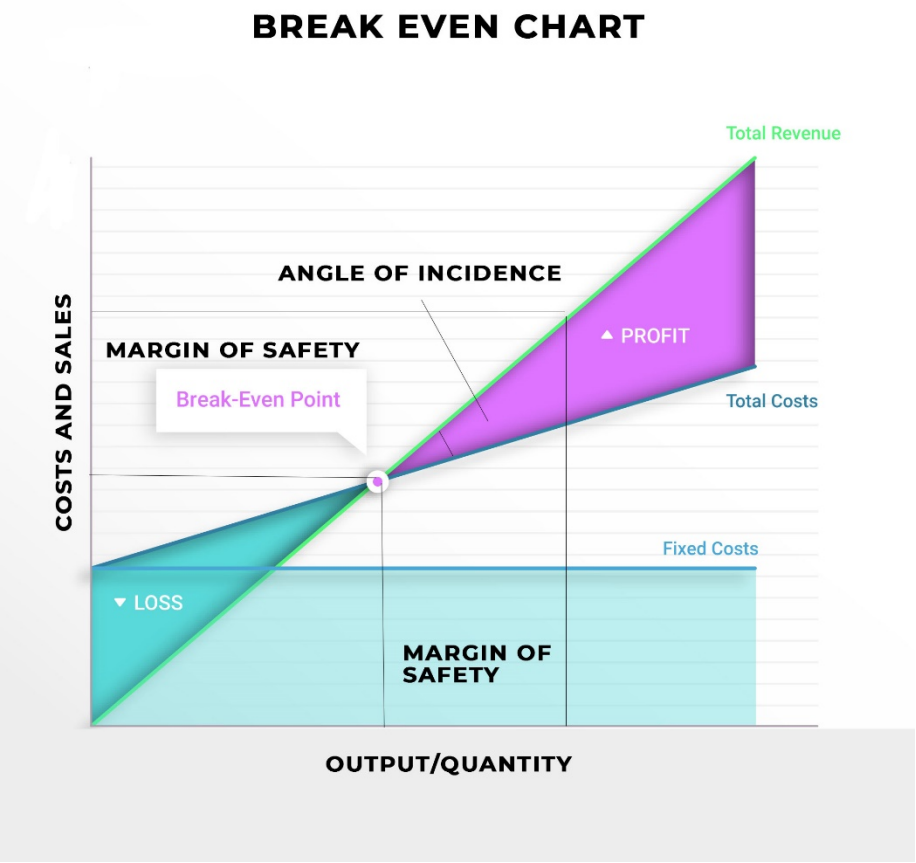

Fig 4 : The graphical representation of breakeven analysis (Source : bbmantra.com)

Case Study

Let us understand the concept through a live case study.

In a hilly terrain there is a 100 bedded Govt Hospital where a need is felt to have ultrasound facility for supporting Mother and child Health care services to reduce NMR and MMR by way of early diagnosis of twins, placenta praevia and other foetal and maternal conditions.As on date the patients are referred to a facility in the plains and apart from delayed diagnosis and interventions, a travel time of four hours is involved.

The Govt reimburses **Rs 600** to the employees that includes the cost of Ultrasound and travel costs in a combined hired taxi or civil bus. The Hospital wants to acquire an ultrasound machine which has a **Fixed Cost** of **Rs 10 lakhs** including **Comprehensive Maintenance** for **7 years**. There is no additional labour cost since the Govt hospital has its own Radioimaging personnel but there is an added expenditure on X Ray Film, electricity, jelly and other material of **Rs 100 per patient. Should the Hospital buy the equipment or continue its current practice of reimbursement?!**

The Solution

The Outcomes

- Early diagnosis and treatment
- Reducing Travel Time and Loss of Productivity
- Reduced Infant Mortality
- Reduced Maternal Mortality

The Economics

- Fixed Cost = Rs10,000,00
- SP per Unit is Rs 600
- VC per Unit is Rs 100
- Q (BEP) = 10,000,00/ (600- 100) = 2000

The Result

It may be appropriate for the Hospital to buy its own Ultra sound machine as it is meeting the needs of the patients in terms of outcomes and economically within 2 years the cost of the machine will be recovered since the BEP is 2000 Ultrasounds and approximately every year 1000 ultrasounds are done.

After two years the Govt shall also be saving money as the equipment would have recovered it costs within the two third of its economic life cycle of seven years.

Case Study for you to solve

A 500 mA X Ray unit can do **250 IVUs in one month**. The **anticipated workload is 150 IVU** in a month and the **economic life cycle of the machine is 5 years**. **VC is Rs 400 per IVU** which is done for **each patient @ Rs 500**. **Fixed overheads per month are Rs 12000**. Will you **procure** the equipment or **outsource** the Investigation. Will your decision be the same if the machine works at **90% of its capacity. The solution is available at the end of the text. Please solve it first and don't rech out to the solution immediately.**

Assumptions underlying Breakeven Analysis

The Breakeven analysis is a useful concept for procuring technology but it comes with certain assumptions. These are

- VC remains constant per unit volume. This may not be true as cost of material, labour and indirect expenses like electricity may rise over a period of time.
- Total fixed costs remain constant throughout the planned range of activity. As equipment ages the technology may require greater maintenance and spare parts
- Efficiency of operations remains unchanged throughout. It may be possible that technologists or the operating personnel may not be available for certain duration of time.
- All costs can be segregated into fixed and variable.
- Selling price per unit of sales remain constant. This may not be the case since as competition increases and technology becomes available to everyone the selling price may have to be brought down.

Inspite of these assumptions and constraints BEA has several applications. These are enumerated below

- In equipment selection and procurement decision
- In setting flexible budgets
- In determining safety margin of key equipment and services
- In introducing cost containment programmes
- In formulating price policy
- In making add / drop or make / buy decisions
- In Performance Evaluation

The next economic concepts that we will seek to decipher are Cost Benefit and Cost Effective Analysis.

Cost Benefit Analysis (CBA) is carried out wherein we can assign costs to both inputs and outputs in monetary terms. The costs of benefits are compared with the costs of the inputs and the interventions that provide maximum benefit vis a vis the costs are selected for implementation. The aim is maximize the returns on investments in various interventions in monetary terms. Decision makers can use CBA to compare both healthcare and non-healthcare interventions since CBA provides monetary values to both inputs and outcomes. One can thus compare investments and outcomes in healthcare vs defence or in maintenance of security.

In CBA Costs include not only the cost of acquiring a Healthcare intervention or technology but also the cost of implementation. Benefits that accrue from the healthcare technological interventions include the monetized value of health improvements, therapeutic costs averted and productivity gains made.

If we were to do the cost benefit analysis of the vaccination programme we can list the benefits in monetary terms for a given set of population as medical costs averted for curing and caring during the occurrence of the disease, cost of productivity hours saved etc and cost of vaccination would include the cost of vaccine, the manpower, infrastructure and training costs involved in implementing the vaccination programme. The net benefit would be calculated in monetary terms by subtracting the cost of the vaccination programme in Rs from the benefits attained in Rs.

Let us take a simple example for illustration only.

The cost of lifestyle interventions and an antihypertensive drive programme in the workplace having 50 employees suffering from hypertension is say Rs One Lakh. On an average an employee loses 20 days in a year due to headaches and other symptoms associated with hypertension. Assuming that average daily salary is Rs 200 there is a total loss of not only 50 x 20 ie 1000 man days of productivity but also a total loss of Rs 200 x 1000 ie Rs 200000. In essence net benefit of this lifestyle intervention is Rs 200000 – Rs 100000 = Rs One Lakh

CBA is **not commonly** used in health technology assessment due to **difficulty of assigning monetary values with health outcomes such as (increased) survival**.

Most commonly CBAs have been used to assess large capital development projects (new hospital facilities) or interventions that improve waiting times or location/access to services or reduce the losses associated with productive times.

Under the circumstances where it is not feasible to assign monetary values to benefits accrued the analysis most commonly used is Cost Effective Analysis

Cost Effective Analysis (CEA)

In CEA the Inputs ie costs incurred are in monetary terms but the Outputs are expressed in terms of results achieved / expected to be achieved. **Eg no of lives saved, no of quality adjusted life years, no of days free from disease .**

Cost Utility Analysis is one of the ways of performing Cost Effective analysis wherein the output is in terms of Quality Adjusted Life Years (QALYs) or Disability Adjusted Life Years (DALYs)

The following **steps** are involved in Cost effective analysis

- Problem Statement or Identifying Objectives
- Identifying alternative solutions
- Identifying and measuring costs
- Identify and measuring effectiveness
- Analysing Cost Effective ratio
- Conducting sensitivity analysis

We will do a **small illustration on Cost Effective Analysis.** We all know that earlier we used to provide Domiciliary Treatment in our Tuberculosis Control Programme. This was subsequently replaced by DOTS (Directly Observed Treatment Short Course. This replacement was consequent to a Cost Effective Analysis wherein Systems Costs, Productivity and Transportation costs were all taken into consideration and effectiveness was ascertained in terms of mortality reduction and reduced prevalence of Tuberculosis including drug and multi drug resistant tuberculosis. This reduction in mortality and drug resistance may be taken under a common head stating Lives saved due to DOTS

Let us call domiciliary treatment as Healthcare Intervention A and DOTs as Healthcare Intervention B. Let us do the analysis

Health care Alternative	Cost
A	Rs 25000
B	Rs20000

Purely in terms of minimizing costs we are tempted to select Healthcare Intervention A. Let us now examine from the effectiveness point of view.

Health care Alternative	Lives saved
A	100
B	40

Clearly Healthcare Alternative A is more effective. Now we look at the Cost Effectiveness of the alternatives.

Health care Alternative	Cost Effectiveness in terms of Lives saved
A	25000 / 100 = Rs 250 per life saved
B	20000 / 40 = Rs 200 per life saved

When we divide costs incurred with effectiveness it gives us the cost effectiveness ratio. In the above case the CE Ratio is higher for Healthcare Alternative A and that forms the basis of our decision to implement that alternative and discard alternative B.

Conclusion

Procurement of Healthcare Technology is an organized process which is determined by many factors that could be related to the society, the ethical and legal aspects of health care, the cost benefit and effective analysis and the relevance of the investment in terms of the returns expected and the time duration required for the technology to break even. The outcomes of any healthcare intervention forms the basis of decision making and these outcomes include reduction in mortality, morbidity, discomfort and disability

The various economic evaluation tools covered in this model are aids to decision making and cannot be considered as the decision itself since decisions are based on logical and rational thinking, on evidences in favour of the decision and above all keeping the larger good of society in mind. The concepts deliberated and discussed in this sub module provide the necessary aids that can make procurement of healthcare technology more beneficial and effective and provide a rational basis for decision making in the procurement process

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The case study

A 500 mA XRay unit can do **250 IVUs in one month**. The **anticipated workload is 150 IVU** in a month and the **economic life cycle of the machine is 5 years**. **VC is Rs 400 per IVU** which is done for **each patient @ Rs 500**. **Fixed overheads per month are Rs 12000**. Will you **procure** the equipment or **outsource** the Investigation. Will your decision be the same if the machine works at **90% of its capacity.**

The Solution

Let us first calculate the number of IVUs required to Break even in a month

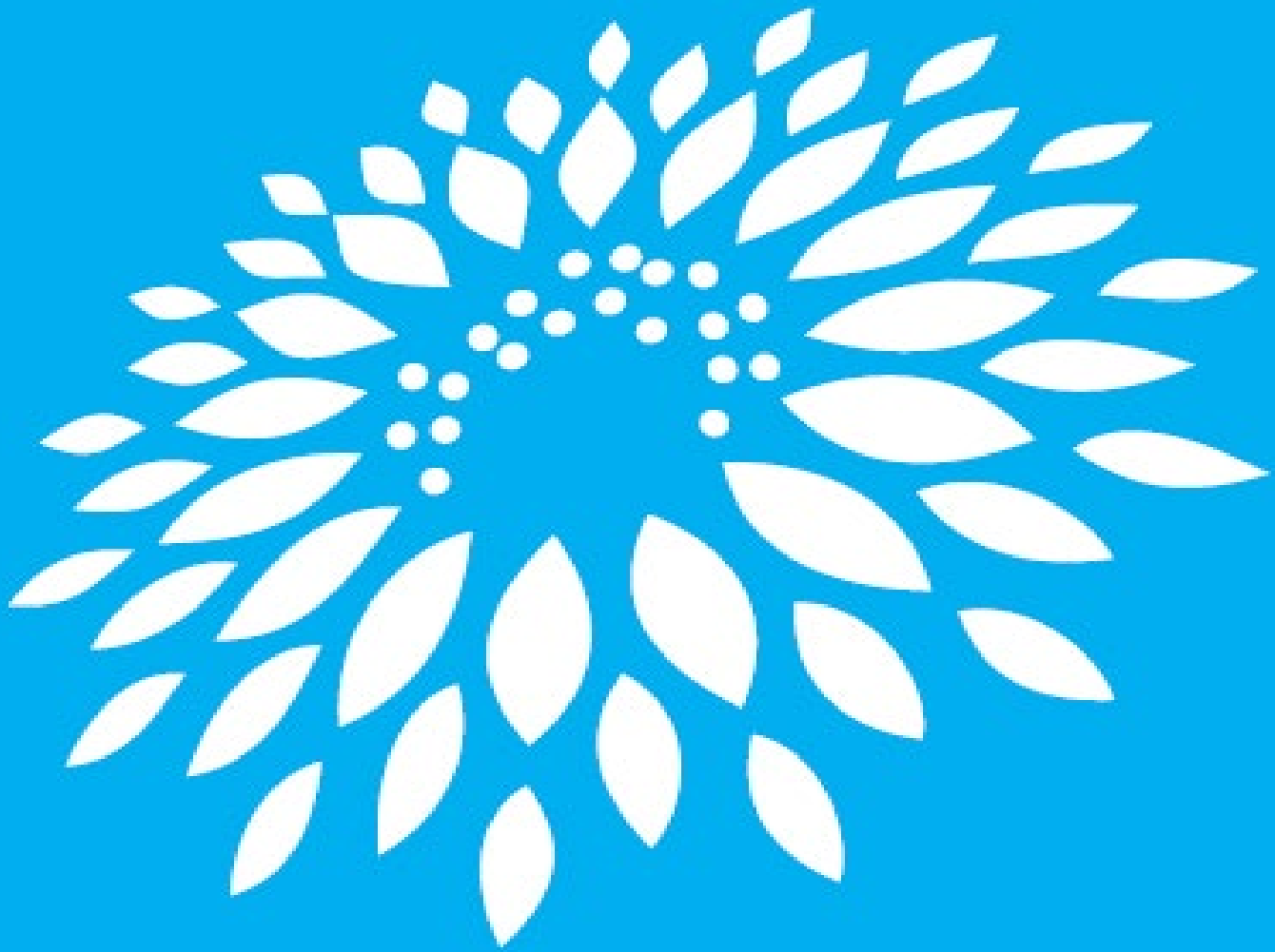
BEP in Quantity (Q) for IVU = FC / Contribution per IVU

BEP in Q = 12000/ 500-400 = 12000/ 100 = 120 IVU.

As 120 IVUs are required to be done in one month to Break Even and the equipment is doing 150 per month, it will be more cost efficient to have own facility

At 90% capacity the equipment will be able to do 250 x 90/ 100 IVUs which is = 225. Currently this fact will not affect our decision to procure the machine since we do 150 IVUs in a month and our breakeven quantity is 120.

Presentations



PUBLIC HEALTH FOUNDATION OF INDIA

Indian Institute of Science

Indian Institute of Space Science and Technology

ASSOCIATION OF HEALTHCARE PROVIDERS INDIA

Certificate Course in

Healthcare Technology (CCHT)

PROCUREMENT OF TECHNOLOGY IN HEALTH CARE : ECONOMICS VS OUTCOMES

CERTIFICATE COURSE IN HEALTHCARE TECHNOLOGY

Air Marshal (Dr) Pawan Kapoor (Retd)

- **Qualifications** : MBBS (AFMC,Pune), MHA (AIIMS), DNB (Health and Hospital Admin), DHHM, M Phil, MMS,MBA,FAHA
- **Appointments held**: Former Director General Medical Services Indian Air Force, Former President Honorary Surgeon
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- **Publications** : More than 50 in National, International journals and text books
- **Awards** : AVSM (2018),VSM (2009 and 2017),COAS Commendation(1980,2004, 2008), His Order of the Royal Emblem from Sultan of Oman (1984)
- **Contribution to Projects**: Regional Paramedical Institute at Aizwal, Mizoram, Army College of Medical Sciences, New Delhi, Planning and designing of Emergency services in Delhi Metropolis, “IREACH” and “Mission Zindagi” Programmes in Indian Air Force
- **Other Achievements**: One of the Founder members of NABH and been Chair of Technical and Accreditation and Ethics Committee

The Prelude: What you have learnt so far

- HTA plays a major part in evidence-based decision-making.
- Without good evidence, the uptake and diffusion of health technologies is likely to be influenced by a range of social, financial and institutional factors.
- This may result in suboptimal health outcomes and inefficient use of resources

What you are going to learn today?

- Efficient Use of available health resources.
- To provide effective outcomes.
- By one of the tools of Health technology assessment ie Economic Evaluation of Health care technology

Learning Objectives

1. Defining Procurement
2. Defining Healthcare Technology
3. Comprehending the Factors involved in procuring healthcare technology
4. Defining Economics and Outcomes
5. Understanding the Tools of Economic Evaluation

Defining Procurement

- Procurement refers to **techniques, structured methods, and means** used to **streamline an organization's procurement process** and **achieve desired results** while **saving cost**, reducing time, and building win-win supplier relationships.

- The goal of procurement is to provide the **right product or service** of the **right quality** from the **right source** at the **right place** at **right time** in the **right quantity** for the **right people** and at the **right price**

Is this all about Steps involved in Procuring Health care Technology ?

- **Yes and No**
- We shall discuss procurement but not in the classical way
- **Yes,** you shall be familiarized with the steps involved in procurement
- **No,** the steps shall not be the focus
- We shall **focus more** on **economics and outcomes** as variables in **procuring healthcare technology**

Let us get the steps out of the way

- **PLANNING AND NEED ASSESSMENT**
- Budgeting and Financing
- Market Surveys
- Making of Technical specifications
- Tendering Action or Requesting for Quotations (Technical and Commercial bids)
- Technical and Commercial Bid Evaluation
- Contract Negotiation and Placing of Supply orders
- Contract management and evaluation
- Other aspects are based upon the Healthcare Technology being procured

Let us get the steps out of the way

Defining Healthcare Technology

Healthcare **technology** is defined by the World Health Organization as the "application of **organized knowledge and skills** in the form of **devices, medicines, vaccines, procedures, and systems** developed to solve a health problem and improve quality of lives".

Classifying Healthcare Technology

Traditionally healthcare technology can be classified as under

1. **Therapeutic** that includes Drugs, Devices, Instruments and equipment that are utilized for cure and care purposes
2. **Diagnostic** that includes technologies adopted in the diagnostic services like Laboratory, Radiology and several others like ECG, EEG etc
3. **Monitoring** that includes devices like various Temperature and BP monitoring devices, cardiac monitors etc
4. **Preventive** ie Vaccines etc
5. **Information based** ie Electronic Medical records
6. **Process** and **Systems** based

Now we have **Digital based technologies**, **Decision Support systems**, **Artificial Intelligence**, **Internet of Things**, **Telemedicine, Tele Radiology, Tele Pathology ETC……**

Factors involved in procuring healthcare technology

- Social
- Ethical
- Legal
- Economical
- Effective

Some Questions related to Procurement

1. Should I buy an Ultrasound/256 slices CT / 3 Tesla MRI machine or should I outsource?!

2. Will my investment in health care technology give me appropriate returns?!

3. What is the cost of one fully vaccinated infant?!

4. What should be the charge of a Laboratory test?!

Some Questions

5. Which is an economically more viable alternative for reducing diarrhoeal mortality?
   - setting up ORBs
   - improving environmental sanitation

6. Should the country invest more in Defence or in Health?

7. Should we invest more in Fertility programmes or in population control programmes?

Defining Economics

- The study of how individuals and societies choose to **allocate scarce productive resources** among **competing alternative uses** and to **distribute the products from these uses** among **members of the society**. (World Bank, 2001)
- Economics relates to **allocative efficiency** in times of **scarcity**
- Health economic studies provide information to decision makers for **efficient use of available resources** for **maximizing health benefits**

Defining Outcomes in Healthcare

- Early Diagnosis
- Early Treatment and return to Productivity
- Change in health related behaviour
- Quality Adjusted Life Years
- **Mortality**
- Morbidity
- Disease Prevention
- Health Promotion

Broad Concepts which we shall cover that relate to Economics and Outcomes

- Scarcity, Margin and Utility
- Production function
- Demand
- Externalities
- Cost concepts and Opportunity cost
- Time value of money
- Break even analysis
- Cost benefit analysis
- Cost effective analysis

Scarcity

- Health resources are scarce
- Demands for health services are unlimited
- Demands are recurring in nature

SO

Choices are to be made to allocate scarce health resources in order to maximize output within available inputs

Margin

- If Health resources are scarce
- One has to be careful about utilization of each and every additional unit of the resources
- Egs – Additional output expected by using additional physician or equipment
- Additional investment say in CT scan has to be taken in view of the additional return from the investment

Utility

- **Capacity to satisfy** a human need directly or indirectly
- Provides a dimension by which to measure the want satisfying capacity of an item, service, equipment and it contributes to the **effectiveness** of an organisation

Law of Diminishing Marginal Utility

- Utility is a function of quantity
- **More input** is added , **more the total satisfaction** derived BUT
- It is a feature of marginal utility that **it diminishes with an addition of the same input**
- As total **utility increases**, **marginal utility decreases.** When TU is maximum MU becomes zero

Production Function

- Expresses the relationship between the amount of various inputs used in the production process and the level of output achieved
- Production Process in health sector refers to various clinical, nursing and diagnostic processes

Production Function

- **Inputs** are in terms of physicians, nurses , diagnostic tools etc
- **Output** is expressed in terms of patients seen, admissions, discharges, deaths averted / prevented etc

APPLICABILITY OF PRODUCTION FUNCTION GIVES AN IDEA OF

Technical Efficiency

- Deals with the mix of inputs which will produce a given output
- Given the resources in the health sector obtaining the maximal possible output
- Alternatively while producing a given output in the health sector utilizing the minimal possible resources

Economic Efficiency

- Deals with the least cost combination of the inputs which will produce the desired output
- Given a fixed budget is the output maximized
- Given a fixed output is the total cost minimized

Scale Of Efficiency

- **Constant**
- **Increasing**
- **Decreasing**

Constant Returns To Scale

- **Inputs increased in equal proportional amounts, output increases at a constant rate**
- **If physicians time, nursing hours , supplies and eqpt and beds are increased by 10 % the OPD cases disposed , discharges from the hospitals and health programme results also increase by 10%**

Increasing Returns To Scale

- **Inputs increased in equal proportional amounts, output increases at increasing rate**
- **If physicians time, nursing hours , supplies and eqpt and beds are increased by 10 % the OPD cases disposed , discharges from the hospitals and health programme results also increase by 15%**

Decreasing Returns To Scale

- **Inputs increased in equal proportional amounts, output increases at decreasing rate**
- **If physicians time, nursing hours , supplies and eqpt and beds are increased by 10 % the OPD cases disposed , discharges from the hospitals and health programme results increase by 5%**

Demand

- Mere expression of health needs and wants do not become demands or effective demands UNLESS
- They are backed or supported by willingness and ability to pay for these needs and wants

Demand

- The ability to pay and sacrifice for securing health care services could be viewed in monetary and non monetary terms.
- Services provided by the Govt should not be viewed in the strict economic sense as free of cost.
- Remember Health is Welfare and therefore to remain **"Well"** some **"Fare"** is to be paid

Demand

- To avail so called free services one has to make sacrifice in terms of traveling time , transportation cost and waiting time etc
- In addition the social costs involved have also to be taken in to consideration

Externalities

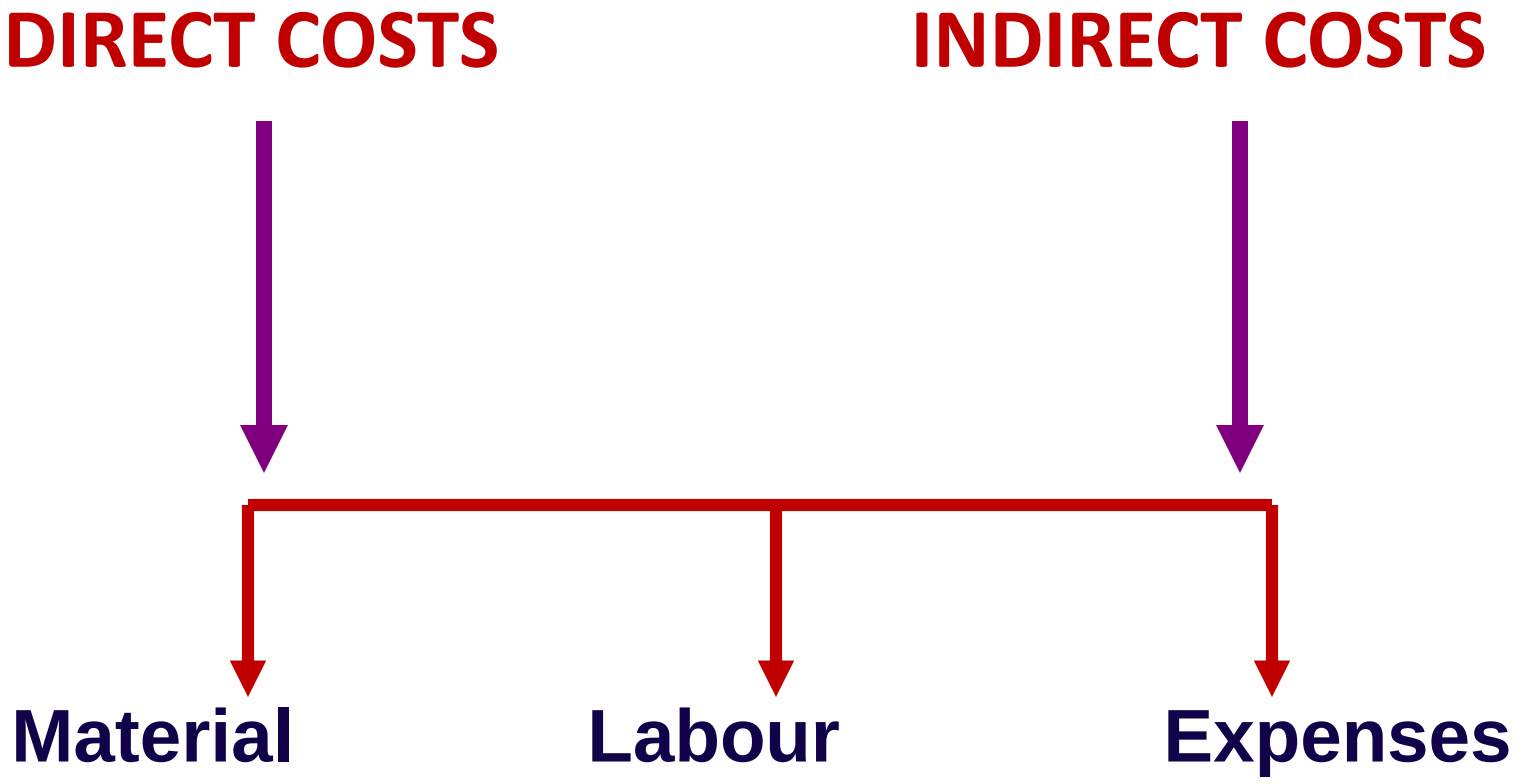
- Describes Hidden or visible benefits or losses to third party
- Overall community or spill over effect of health care activities or programmes that are not consciously taken into account in production or pricing decisions

Externalities

- These externalities may generate extra benefits or losses to society
- Preventive efforts can reduce expenditure on curative treatment
- Suffering and losses due to pollution from unplanned and haphazard industrialization / transportation.

Let us now know something about Costs

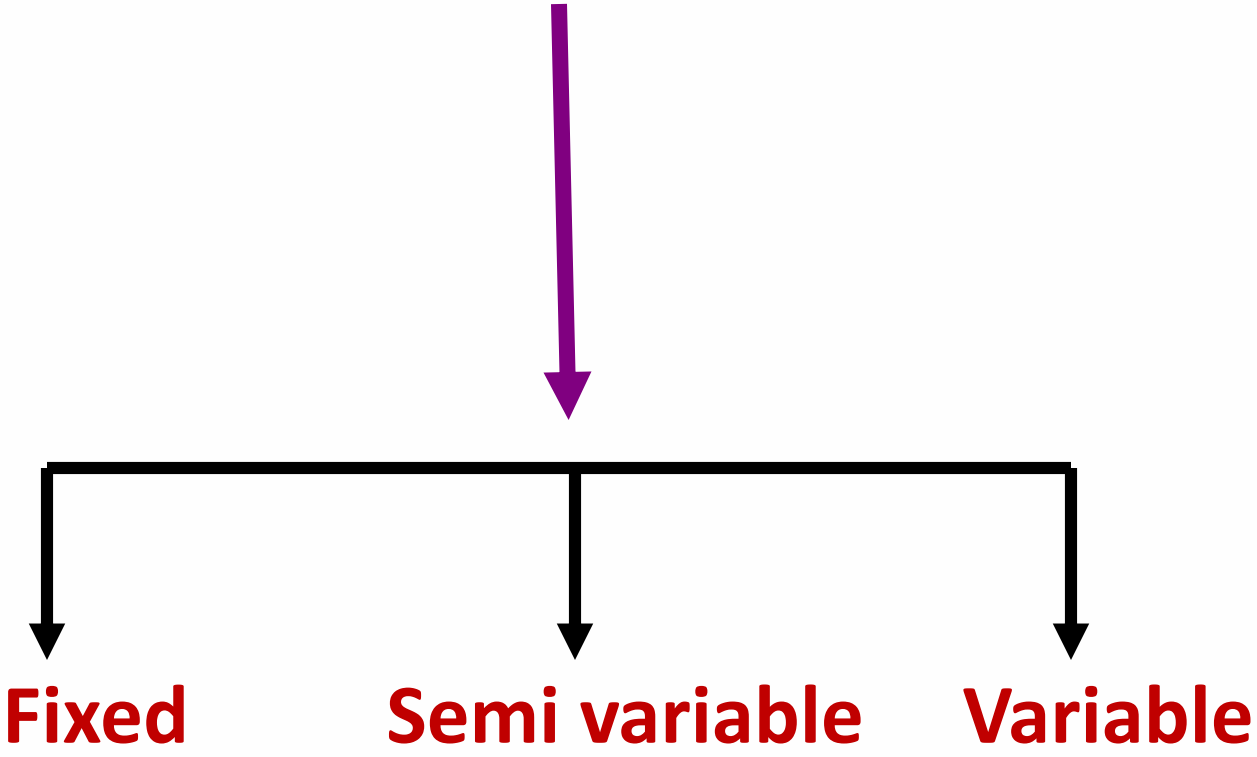
Elements Of Cost



Overheads

- **Indirect Material**
- **Indirect Labour**
- **Indirect Expenses**

Cost Classification



Types of cost

- **Fixed : Does not vary with number of outputs**
- **Variable: Varies with the output**
- **Direct Costs : Health care related costs**
- **Indirect Costs : Loss in productivity as a result of illness/death/ & care-givers time**
- **Overhead Costs : Costs which are shared by more than one cost centres**

One More concept of Cost: Opportunity cost

The cost of committing resources for one particular use is the benefits that are foregone by not committing them to their most valued alternative use

Opportunity cost

- **The real cost of a new drug, for example, is the other drugs and / or services that may not be available (either in the health sector or elsewhere)**

- **Money enters the analysis *only* as a unit of measurement**

Information on Cost of Health Services – Why?

- For good planning and management of Health care
- Leading to efficient use of resources that focus on efficiency and effectiveness of healthcare interventions and technologies
- For determination of user fees by health agencies
- For determination of community health insurance schemes

Illustration

- A diagnostic Lab is presently doing 1000 Hb tests @ Rs 10 per test. VC per unit is Rs 5 and the total fixed costs are Rs 4000
- The Lab has now recd a contract from the Govt for doing 200 tests @ Rs 8 per test
- The execution of this contract will increase fixed cost by Rs 200
- Should the Lab take on this contract. Will it be beneficial to the Lab

	Existing situation		Proposed Situation		Incremental	
	Rs	Rs	Rs	Rs	Cost	Revenue
Sales		10000 (1000 x 10)	10000 + 200 x 8	11600 (10000 + 1600)		1600
Less VC	5000		6000			
Less FC	4000	9000	4200	10200	1200	
Profit		1000		1400		400

Break Even Analysis

- Total Revenue = Total Cost
- Total Revenue = Selling Price Per Unit (SP) X Quantity
- Total Cost = Fixed Cost (FC)+ Variable Cost per unit (VC per Unit) X Quantity (Q)
- SP per Unit X Q= FC + VC per Unit X Q
- SP per Unit X Q – VC per Unit X Q = FC
- Q (SP-VC)per Unit = FC
- Q= FC/ (SP - VC) Per Unit

This means that the Quantity at which Technology Breaks Even is its Fixed Cost divided by the difference of Selling Price and Variable Cost per Unit

Formulae For BEA

1. BEP in Output = FC/ Contribution per unit
2. BEP in Rs / Sales = $\frac{\text{FC x SP / unit}}{\text{Contribution per unit}}$

   $= \frac{\text{FC x Total sales}}{\text{Total contribution}}$
3. Units for desired profit = $\frac{\text{FC + DP}}{\text{Contribution per unit}}$

Case Study

1. In a hilly terrain there is a 100 bedded Govt Hospital where a need is felt to have ultrasound facility for supporting Mother and child Health care services to reduce NMR and MMR by way of early diagnosis of twins, placenta praevia and other foetal and maternal conditions
2. As on date the patients are referred to a facility in the plains and apart from delayed diagnosis and interventions, a travel time of four hours is involved

Case Study

3. The Govt reimburses **Rs 600** to the employees that includes the cost of Ultrasound and travel costs in a combined hired taxi or civil bus.
4. The Hospital wants to acquire an ultrasound machine which has a **Fixed Cost** of **Rs 10 lakhs** including **Comprehensive Maintenance** for **7 years**.
5. There is no additional labour Cost since the Govt hospital has its own Radioimaging personnel but there is an added expenditure on X Ray Film, electricity,jelly and other material of **Rs 100 per patient**
6. Should the Hospital buy the equipment or continue its current practice of reimbursement?!

Case Study

6. The Ultrasound machine has an **economic life cycle of 10 years**
7. In the preceding year approximately **1000 Ultrasounds** had been referred and reimbursed.
8. Should the Hospital **buy the equipment** or **continue its current practice of reimbursement**?!

The Solution

The Outcomes

- Early diagnosis and treatment
- Reducing Travel Time and Loss of Productivity
- Reduced Infant Mortality
- Reduced Maternal Mortality

The Economics

- Fixed Cost = Rs10,000,00
- SP per Unit is Rs 600
- VC per Unit is Rs 100
- Q (BEP) = 10,000,00/ (600- 100) = 2000

The Solution

- It may be appropriate for the Hospital to buy its own Ultra sound machine as it is meeting the needs of the patients in terms of outcomes and economically within 2 years the cost of the machine will be recovered since the BEP is 2000 Ultrasounds and approximately every year 1000 ultrasounds are done.
- After Two years the Govt shall also be saving money

Case Study for you

- A 500 mA X Ray unit can do **250 IVUs in one month**. The **anticipated workload is 150 IVU** in a month and the **economic life cycle of the machine is 5 years**
- **VC is Rs 400 per IVU** which is done for **each patient @ Rs 500**. **Fixed overheads per month are Rs 12000**. Will you **procure** the equipment or **outsource** the Investigation. Will your decision be the same if the machine works at **90% of its capacity.**
- **The solution is available in the background material provided to you**

Assumptions Underlying BEA

- ✓ VC constant per unit volume.
- ✓ Total fixed costs remain constant throughout the planned range of activity.
- ✓ Efficiency of operations remains unchanged throughout.
- ✓ All costs can be segregated into fixed and variable.
- ✓ Selling price per unit of sales remain constant.

Application Of BEA

- ✓ In equipment selection and procurement decision
- ✓ In setting flexible budgets
- ✓ In determining safety margin of key equipment and services
- ✓ In introducing cost containment programmes
- ✓ In formulating price policy
- ✓ In making add / drop or make / buy decisions
- ✓ In Performance Evaluation

Cost Benefit Analysis

- **Inputs and socially relevant outcomes are both measured in monetary terms**
- **Eg outsourcing of housekeeping / laundry services vis a vis own services**
- **Ultimate unit of measurement is money value to society**

Cost Benefit Analysis

- CBA is **not commonly** used in health technology assessment due to **difficulty of associating monetary values with health outcomes such as (increased) survival**.
- Most commonly CBAs have been used to assess large capital development projects (new hospital facilities) or interventions that improve waiting times or location/access to services.

Cost Effective Analysis

- Inputs in monetary terms
- Outputs are expressed in terms of results achieved / expected to be achieved
- Eg no of lives saved, no of quality adjusted life years, no of days free from disease

Steps In CE Analysis

- Define problem / objectives
- Identify alternative solutions
- Identify and measure costs
- Identify and measure effectiveness
- Analyse Cost Effective ratio
- Conduct sensitivity analysis

Sample In C E Analysis

HEALTH CARE ALTERNATIVE	COST
A	25000
B	20000

HEALTH CARE ALTERNATIVE	EFFECTIVENESS
A	100 LIVES SAVED
B	40 LIVES SAVED

HEALTH CARE ALTERNATIVE	COST EFFECTIVENESS
A	250 / LIFE
B	500 / LIFE

Take  Messages

- Human wants are infinite but resources are Finite
- Economics is as much about benefits as it is of costs
- Choices in healthcare (that is in health planning or in treatment mode) inexplicably involve value judgment that cannot be easily converted into monetary values
- We have, therefore perforce to consider the costs and effectiveness of the technology to be procured
- Many of the simple rules of market operations do not apply in the case of healthcare.

Take  Messages

- **Consideration of costs is not necessarily unethical**
- **Most choices in health care relate to changes in the level or extent of a given activity, the relevant evaluation concerns these marginal changes, not the total activity.**
- **The provision of health care is but one way of improving the health of the population.**
- **As a community we prefer to postpone costs and to bring forward benefits.**
- **Equity in health care is desirable, but reducing inequalities usually comes at a price.**

Thank You

For more Information please contact

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