CHAPTER 3

METHODOLOGY

3.1 Study Design

This study is cross sectional descriptive study by collected the data from laboratory unit in public hospital and private clinical laboratory during October 1998 to September 1999 and the data from patients and physicians during February 2000. Data from laboratory unit was used to assessed the cost recovery, while data from patient and doctor were used to determined factors influencing utilization of Automated Clinical Analyzer.
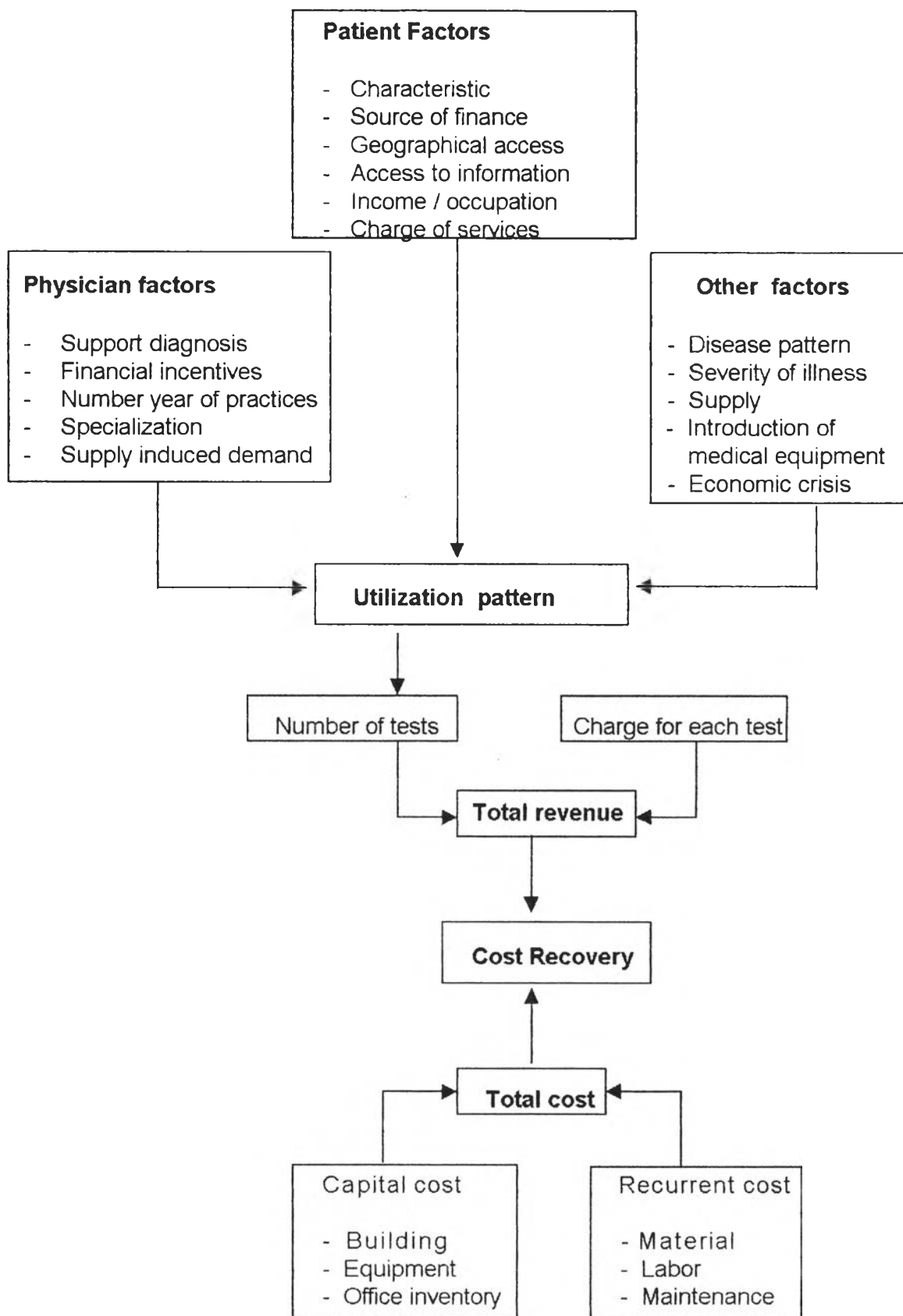
3.2 Conceptual Framework

This study is proposed to determined the factors influencing the utilization of Automated Clinical Analyzer and to estimate the total cost, total revenue and the cost recovery of laboratory tests using ACA as well. The conceptual framework is presented in Figure 3.1. This figure shows factors affecting the utilization of ACA can classify into physician, patient and other factors. Cost, revenue and cost recovery will be described as well.

1) Physician factors.

From physician factors, the reason to refer to laboratory such as the result can support the diagnosis, financial incentive can affect the utilization of ACA. Kinds of specialists and number year of practice also influence the utilization. It was indicated that young doctors tended to request more examination test in order to support the diagnosis.

Supply induced demand can explain by the quantity of laboratory test service provided. The greater the numbers of tests provide, the greater the number of tests are ordered by the physician. So, demand created by physician.

Figure 3.1 Conceptual Framework

Patient Factors

- Characteristic
- Source of finance
- Geographical access
- Access to information
- Income / occupation
- Charge of services

Physician factors

- Support diagnosis
- Financial incentives
- Number year of practices
- Specialization
- Supply induced demand

Other factors

- Disease pattern
- Severity of illness
- Supply
- Introduction of medical equipment
- Economic crisis

Utilization pattern

Number of tests

Charge for each test

Total revenue

Cost Recovery

Total cost

Capital cost

- Building
- Equipment
- Office inventory

Recurrent cost

- Material
- Labor
- Maintenance

2) Patient factors.

From patient factors, the characteristic of patient such as education, age, income and occupation can influence the decision to utilize medical services. The older group has more demand for medical care since their health status is relatively low. As income levels have risen, demand for more and better quality health care have increased. Source of finance and access to laboratory also affect patient to utilization decision. Physical access can result in loss of income from the time and transport cost.

Access to information of services provides, those who have more information about the advantage of advance technology will utilize that technology and know when to seek help. A positive relationship appears to exist between consumers' medical knowledge and the demand for medical care. This means that consumers with a more extensive background in medicine and medical equipment tend to consume more medical services.

In public sector the charge is lower than private sector. Public hospital applied the itemized charge into class 1, class 2 and class 3, while private sector applied flat fee. Charges systems such as itemized charges and flat fee influence the utilization. In economic point of view if the price falls, then the quantity demanded will increase. On the contrary, the higher price will then lead to smaller quantity demanded. When concern with equity, flat fee system can be said as equally to access for everyone, while itemized charge should be provided for the low income group, in other words exemption for the poor can be drawn from the different charges.

3) Other factors.

There are also many other factors that can influence the utilization. Disease pattern and severity of illness, more serious illness, will increase the demand for utilizing the medical services. Infectious diseases have been reduced, but not eliminated, by earlier health care advances. However, chronic ailments, such as cardiovascular disease and cancer, whose treatment and prevention are more costly, are becoming more prominent to the elderly.

Introduction of new medical equipment can lead to higher demand of medical care. Medical devices and equipment for diagnosis or treatment are often readily used to supporting the diagnosis than preventive technology.

Increasing professional specialization and differences in the supply of services have also been identified as causes of over-utilization. On the contrary, the over supply of medical technology greater than demand may cause under-utilization.

Economic crisis had threatened the sustainability of improvement of health indicator. Effectiveness, affordability, financial viability and equity of health care supply were likely to be affected by the increase in costs of medical care, laboratory services and other imported inputs, and the decrease of funding of health care. As a result, the utilization of health services would decrease.

4) Revenue

The utilization patterns will then affect the number of tests. The charge of service provides will affect to the revenue as well. Total revenue estimated by multiplying the charges with the number of laboratory tests which include many tests such as blood chemistry, Liver Function Test, Renal Function Test.

5) Cost

While this study also propose to calculate the cost recovery, it is need to know the total cost as well. The classifications of total costs are categorized into capital cost and recurrent cost. The costs were estimated from the provider point of view. This study applies the direct distribution method as a method of the cost allocation. The cost obtained from the budget from the center of each institution.

The capital cost comprises of construction of building, installation of equipment, purchase of vehicle, investment in human capital (i.e. initial training). The recurrent cost encompasses the material costs (administration, stationary, reagents, electricity, water, telephone, fuel), labor cost (salary and wages), maintenance cost

(building, equipment and spare part) and maintenance of human capital (on the job training).

3.3 Definition

Annualization factor. The amount saved at the end of the year if it is invested in the bank at an annual rate of interest.

Average cost: The cost per unit of output. Also known as unit cost.

Capital costs: Those costs concentrated at the beginning of a project and associated with the establishment of productive capacity and physical infrastructure.

Cost recovery ratio: Ratio of cost that can recover from total revenue over total cost

Current value: The present value of future costs or benefits, which are discounted at a given rate.

Depreciation: The loss in value of an item, due to wear or other reason. Depreciation is usually computed on an annual basis as initial cost per years of useful life.

Discount rate: The rate of interest rate obtained from the bank if the money was put into the bank instead of buying the capital inputs.

Fixed cost: Expenses which do not vary with the quantity of tests e.g. the main office expenses, and rent.

Opportunity cost. The cost that is forgone by using limited resources for a particular purpose.

Recurrent costs: Those costs associated with the operation or maintenance of facilities or assets.

Revenue: The output of production had been sold in terms of money.

Sensitivity analysis: A technique designed to allow for uncertainty by testing whether plausible changes in the value of the main variables would affect the conclusion of analysis.

Utilization rate: Percentage of using ACA which is the total number of tests had been conducted per year of full capacity per year

Variable costs: Expenses that vary according to the level of services provided or number of tests.

3.4 Data Collection.

This study collected the data of production cost and revenue from laboratory unit in public hospital and clinical laboratory, which has Automated Clinical Analyzer to investigate the laboratory tests. Data was collected from the register of laboratory unit of public hospital and clinical laboratory during October 1998 to September 1999. Doctors and patients who used this machine were interviewed to determine the user characteristics and factors influencing the utilization of ACA. Thus, there were primary and secondary data.

1) Target population and sampling technique of facilities.

Target population were public hospital and clinical laboratory that have ACA in their laboratory unit. From 122 public hospitals and 92 clinical laboratories, one sample of each institution was selected purposively, based on the following criteria:
- Type of tests : Blood chemistry, Liver Function Test, Renal Function Test
- Use the same type of machine
- Availability of data required
So, the samples can represent public hospital and private clinical laboratory.

The selected public hospital was type B hospital, while selected clinical laboratory was Type Utama. Type B hospital is general hospital which provides the services of broad specialization and limited sub-specialization. Also as teaching hospital. This hospital has 760 beds. The BOR in 1998/1999 was 53.3% and average length of stay was 6.67 days. The laboratory unit of this hospital provide the basic and advance laboratory examination with modern equipment. Type Utama clinical laboratory is private clinical laboratory that provides basic and advance laboratory examination. It has modern equipment of laboratory and has radiology section as well.

2) Target population and sampling technique of respondents.

Target population of respondents were: (1) The patients whose visit laboratory unit; and (2) Doctors who refer the patients to investigate the laboaratory tests by using ACA. After selecting facilities, sample of patients whose visit laboratory unit during February 2000 in each facility were selected purposively. There were 392 samples of patients from public hospital and 69 samples from clinical laboratory. Meanwhile the samples of 50 doctors were selected purposively from both facilities. The data was collected by interviewing the patients and doctors in each institution.

Table 3.1 Variables and Source of Primary Data.

Factor Influencing utilization	Variable to be measure	Unit measurement	Data source	Instrument
1. Patient factors				
1.1 Characteristics	Type of patient	Categorize in : - OPD - IPD - General check up / Self examination - Emergency	Patient	questionnaire
	Age	Year	Patient	questionnaire
	Education	Categorize in : - Elementary - Primary school - Secondary school - University	Patient	questionnaire
	Occupation	Categorize in: - Government employee - Private employee - Self employee - Farmer/fisher - Labor - Other	Patient	questionnaire
	Income	Rupiah per month	Patient	Questionnaire
1.2 Access to health services	Domicile / residence	Distance in Km	Patient	questionnaire
1.3 Cost (patient view)	Absence of work	Salary loss (Rp/ day)	Patient	Questionnaire
	Travel cost	Cost spent for travelling (Rp/Km)	Patient	questionnaire

Table 3.1 (Continued)

Factor influencing utilization	Variable to be measure	Unit measurement	Data source	Instrument
1.4 Sources of finance	Financing source	Categorize in : - Free of charge - Out of pocket - Public insurance - Private insurance - Social security scheme - Health card - Social safety net	Patient	questionnaire
2. Physician factors				
2.1 Reason to refer for laboratory tests	Supporting diagnosis	Dummy variable 1 = yes, 2 = no	Physician	questionnaire
	Access to laboratory is easy	Dummy variable 1 = yes, 2 = no	Physician	questionnaire
	Patient choice	Dummy variable 1 = yes, 2 = no	Physician	questionnaire
	Financial incentives	Dummy variable 1 = yes, 2 = no	Physician	questionnaire
2.2 Seniority	Number of year practice	Number of year practice	Physician	questionnaire
2.3 Specialization	Specialization	Categorize in : - General practice - Specialist	Physician	questionnaire
2.4 Appropriate use	Confirmation of tests result	Percentage of precise diagnosis	Physician	questionnaire
3. Other factors				
3.1 Disease pattern	Diagnosis	Diagnosis by physician	Physician	questionnaire

Table 3.2 Variables and Source of Secondary Data.

Data to be collected	Variable to be measure	Unit measurement	Data source	Instrument
1. Number of tests	Number of laboratory tests	Categorize in: - At present - Before and after economic crisis	Laboratory unit	Record form
2. Revenue	Charge	Charge per test in Rupiah	Laboratory unit	Record form
3. Cost (provider view)				
3.1 Capital cost	Building ACA Office Inventory	Annual cost in Rupiah	Laboratory unit	Record form
3.2 Recurrent cost	Material	Actual cost for one year: Reagent = Rp/unit Electricity = Rp/kwh Water = Rp/m^3 Transport = Rp/lt Utilities = Rp/unit Phone Rp/pulse	Laboratory unit	Record form
	Labor	Salary = Rp/month		
	Maintenance	Spare part = Rp/unit		

3.5 Data Analysis

3.5.1 Utilization of Automated Clinical Analyzer

Factors influencing the utilization of ACA from patients and doctors viewpoints were analyzed by descriptive method. Statistic Program for Social Science (SPSS) was used to obtain the frequency and other descriptive variable analysis.

Utilization rate was also taken into account. It was calculated, based on utilization per year (total number of tests) dividing by full capacity per year (total operating hours of machine per year multiply full capacity of tests per hour). Total operating hours was obtained from total hours of operating machine per day multiply by six days per week for one year. Assume that the operating machine per day was 10 hour, based on the maximum operating hour in clinical laboratory.
Details as follows:

$$\text{Utilization rate} = \frac{\text{Total number of tests}}{\text{Full capacity per year}} * 100\%$$

Full capacity per year = total operating hours per year * full capacity of tests per hour

Total operating hours per year = maximum opening hour * opening day in one year

Full capacity of tests per hour was obtain from the manual textbook of ACA (Bechman, 1995).

Total number of tests was the number of laboratory tests requested during October 1998 to September 1999.

3.5.2 Cost Classification

This study classified the cost by input into two groups (WHO, 1989):

1) Capital cost

Capital costs are those costs concentrated at the beginning of a project and associated with the establishment of productive capacity and physical infrastructure.

These include the costs of:

- Construction of building
- Installation of equipment
- Purchase of vehicle
- Investment in human capital (i.e. initial training)

If we concern about economic cost, we have to calculate the capital cost including the depreciation and discount rate. Depreciation of capital cost is the loss in value of an item, due to wear or other reason. Depreciation is usually computed on an annual basic as initial cost per years of useful life. Discount rate is the rate of interest rate obtained from the bank if the money was put into the bank instead of buying the capital inputs.

The interest rate in Indonesia during 1991 to 1999 was vary from 12.53% to 23.32%, with average 17.47%. The real interest rate in 1999 was 15.77%, which was nearly the average. Thus this study used the interest rate 15.77%. The data was obtained from the Central Bank of Indonesia.

2) Recurrent cost

Recurrent costs are those costs associated with the operation or maintenance of facilities or assets. Typically, they include the costs of:

- Material cost: administration, stationary, reagents, electricity, water, telephone, fuel.
- Labor cost: Salary and wages
- Maintenance: building, equipment and spare part
- Maintenance of human capital (on the job training)

3.5.3 Calculation of Capital Cost

Because of the building and major equipment last for more than one year, they suffer from continually wear and tear. So the costs must be renewed. To determine this wear and tear that happen annually, the formula below was used.

Since we consider the economic cost, we have to justify the opportunity cost of the capital being used up. Then, we have to compute the capital cost by including the rate of inflation in the purchase price. All of the costs were calculated at 1999 price and then the annual costs of all capital cost items were calculated. To calculate the annual costs of all capital cost inputs, the following information are needed (Carryn and Evlo, 1995):

- Purchase price of the assets at the year bought

- Lifetime of assets

- Interest rate during period of study

- Annualization factors

First, we calculate the current value of the capital assets by using the following formula:

Current value = The purchase price $*$ (1 + interest rate)$^{current\ year\ -\ purchase\ year}$

We also can obtain the current value from the information of current market price which can replace the value of assets.

Then, we should spread the amount of the current value over the n years of the lifetime of the assets, namely annual cost. If we consider to the amount saved if the value is invested in the bank at interest rate per year, then the annual cost of the capital cost can be calculated by using the following formula (Shepard et al, 1998):

$$Annualized\ cost = \frac{Current\ value\ of\ capital\ cost}{Annualization\ factor}$$

Annualization factor is the amount saved at the end of the year if it is invested in the bank at an annual rate of interest. Annualization factor can be computed using the following formula:

Annualization factor = $(1/r) * [1 - 1/ (1 + r)^n]$

Where:

      r = real interest rate

      n = life time of the asset

By using the formula above, the annual capital cost items were calculate as follows:

Purchase value laboratory building = Rp. 193,385,610

Purchase year = 1992

Interest rate in 1999 = 15.77 %

Life time (n) = 30 years

The current value = Rp. $193{,}385{,}610 \, (1 + 0.1577)^{1999-1992}$

                 = Rp. 539,009,455.1

Annualization factor were calculated using discount rate 16% and life time 30 years is 6.177.

Thus, the annual cost of laboratory building = Rp. 539,009,455.1 / 6.177

                                         = Rp. 87,260,718

US$ 1 = Rp. 7,500 in 1999

The other capital cost items were calculated by similar way to obtain the annual cost of laboratory building. To get the total capital cost then summarize all capital cost items.

3.5.4 Calculation of Recurrent Costs.

Cost of each recurrent input were calculated as unit cost of each input and then multiplied by the total number of units used. Recurrent costs in this study comprises of material cost and labor cost. Since the data of recurrent cost was collected within one year in current year, the recurrent cost was calculated as the actual cost without adjusting by the annualization factors. The recurrent cost was yearly basis.

Material cost

The material cost include:

- Stationary
- Reagent
- Medical inventory cost (spuit, etc)
- Maintenance of building and equipment including spare part
- Transportation of delivery service (if any)
- Electricity
- Water
- Telephone

The material cost was computed by obtaining the total number of unit and multiplying by tha price paid for each unit.

Material cost $= \sum_{i=1}^{n} Q_i P_i$

Where:

Q = Number of unit

P = Price of material

Each item of materials cost were calculated in similar way, and then summarize all the material cost items to get total material cost.

Labor cost

Labor cost in public hospital encompasses salary, fringe benefit and incentives, while labor cost in clinical laboratory was obtained from basic salary only. In terms of salary of the laboratory staffs, it is assumed that the staffs work only at the laboratory unit. The labor cost was calculated for one year.

In public hospital, **LC $= \sum$ (BS + FB + I)**

In clinical laboratory, **LC $= \sum$ BS**

Where:

> LC = Labor cost
>
> BS = Basic salary
>
> FB = Fringe benefit
>
> I   = Incentive

All personnel labors cost were calculated in similar way, and then summarize all the labor cost items to get the total labor cost.

After we got the total material cost and total labor cost, then we calculate the total recurrent cost by summary total material cost and total labor cost.

Total recurrent cost = Total material cost + Total labor cost

To get the total cost of laboratory test with Automated Clinical Analyzer was calculated by summarizing the total capital cost and total recurrent cost for each institution (public hospital and clinical laboratory).

Total cost = Total capital cost + Total recurrent cost

3.5.5 Revenue calculation

The revenue of laboratory test with ACA was calculated from the output of ACA utilization in laboratory unit of public and private hospital and clinical laboratory as well. The revenue was derived by multiplying total number of each test with the charges each test. Assumed that all the tests was fully paid, without exemption of the charges

$$\mathbf{Rev = \sum_{i=1}^{n} T_i P_i}$$

Where:

> Rev = Revenue
>
> T   = Total number of each test
>
> P   = Price or charge for each test

The other revenues of each test were calculated in similar way, and then summarize all the revenues to get the total revenue.

3.5.6 Cost Recovery Calculation

To provide the sustainability of services, it is needed to know the cost recovery. The cost recovery ratio was defined as ratio of the cost that can recover from total revenue over total cost. It also implied that utilization of ACA might not be fully utilized. Cost recovery could be computed by dividing total revenue over total cost.

$$\textbf{Cost Recovery ratio} = \frac{\textbf{Total revenue}}{\textbf{Total cost}}$$

If cost recovery ratio (CR) is less than one, it means the cost cannot recover and the operating cost should be used instead of total cost to calculate cost recovery. If CR is equal one, it means the cost of total cost can recover for certain period. Meanwhile, if CR is more than one, it means the program earn profit for that period of time.

3.5.7 Sensitivity Analysis

Sensitivity analysis is a technique designed to allow for uncertainty by testing whether plausible changes in the value of the main variables would affect the conclussion of analysis. It was done on the basis of uncertain variables to ascertain the effects of using different number of unit measurement of variables. Since the two facilities have different mission, then we do the sensitivity analysis separately.

1) In public hospital

   The aim was to calculate the appropriate number of test and appropriate charge.

(1) Appropriate number of tests was calculated based on break-even point.

$$TR = TC$$

Charge per test * Number of tests = TFC + TVC

Charge per test * Number of tests = TFC + (AVC per test * Number of tests)

$$\text{Number of tests} = \frac{TFC}{\text{Charge per test} - AVC}$$

Where:

TR = Total revenue

TC = Total cost

TFC = Total fixed cost

TVC = Total variable cost

AVC = Average variable cost

(2) Given the actual number of tests, the appropriate charge was obtain from total cost divided by number of tests.

$$\text{Charge} = \frac{\text{Total cost}}{\text{Number of tests}}$$

2) In clinical laboratory

Since the aim of private sector was to get the profit, thus the sensitivity analysis in clinical laboratory based on the average profit of the firm, i.e. 20% of the total cost. Given the actual number of tests, what should be the charge.

3) Opportunity cost of personnel or labor cost in public hospital.

Assume that the personnel could have been productively used in competitive market. Using the salary in private sector, the labor cost in public hospital was calculated in the same way as labor cost in clinical laboratory of private sector. Then we obtained the changing in cost recovery ratio by using the opportunity cost of labor cost, instead of actual labor cost in public hospital.