Chapter 3
Methodology

3.1 Study Design

This study is a cost-effectiveness analysis of school vision screening program. The alternatives are different in screening tests (VA test vs. VA test plus stereopsis test) and diagnostic eye care delivery (mobile team vs. refer). Thus the alternatives are as followings:

Alternative 1: vision screening using visual acuity test and stereopsis test by school teachers and provision of refractive eye care by mobile teams. (The original method used in the Sight for Kids program)

Alternative 2: vision screening using visual acuity test by school teachers and provision of refractive eye care by mobile teams.

Alternative 3: vision screening using visual acuity test and stereopsis test by school teachers and detected cases refer to existing health care system.

Alternative 4: vision screening using visual acuity test by school teachers and detected cases refer to existing health care system.

3.2 Conceptual Framework

The author use model simulation to analyze the cost-effectiveness if any one of the alternatives is used in the Sight for Kids program, which has 60 participating schools and 87,534 students. There are two major reasons to do the cost-effectiveness analysis using the simulation model. Firstly, the SFK program is planned to complete in 2005. Secondly, the program uses homogeneous method of screening and diagnostic eye care delivery (as in alternative 1). This study wants to find more information to do the cost-effectiveness analysis to see "what are the results if the SFK program is performed by alternative method?" The economic

evaluation is from societal perspective. The overall conceptual framework is shown in the figure 3.1.

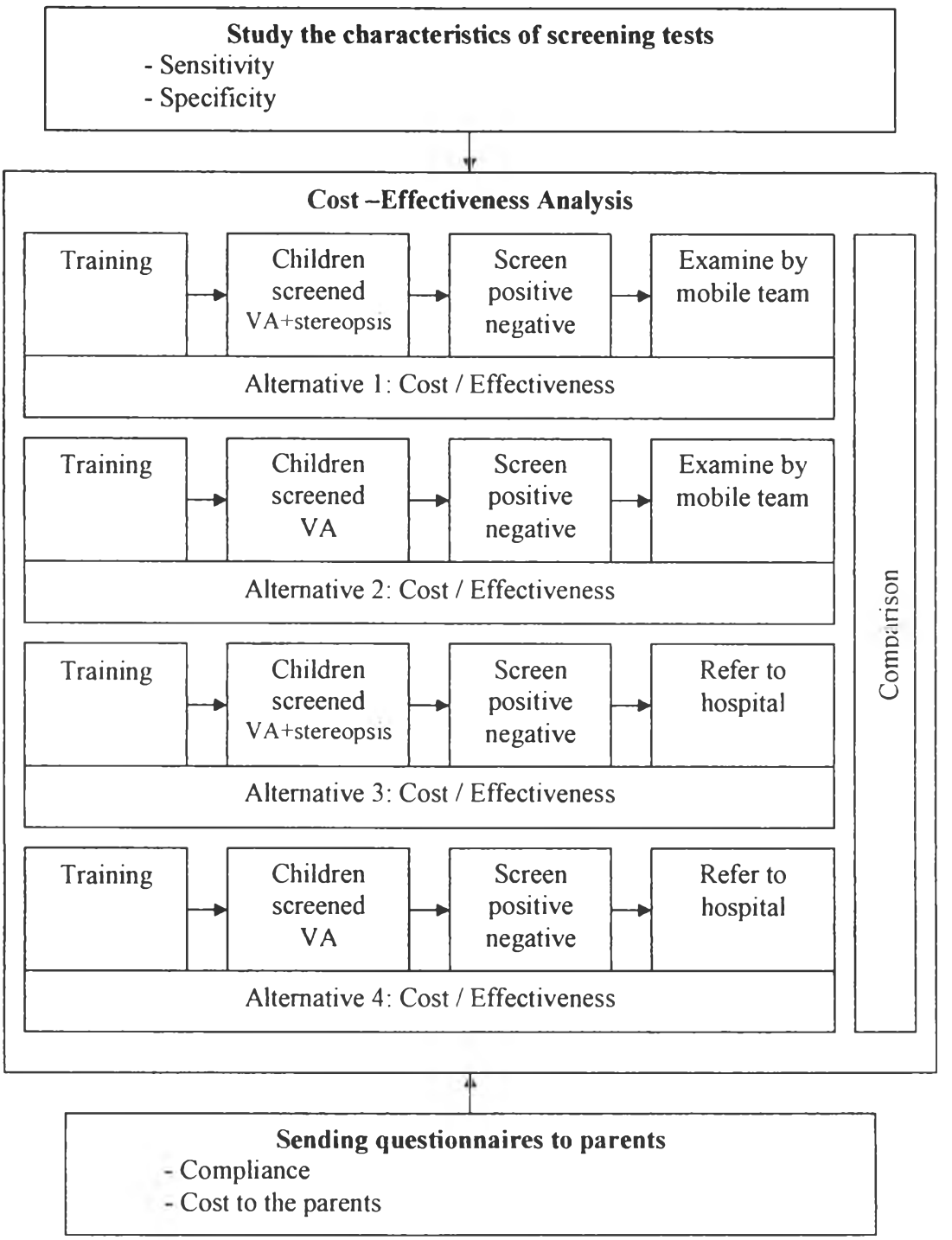

Figure 3.1 Conceptual framework

3.3 Assumptions

To complete the analysis, this study makes some assumptions as followings:

1. The prevalence of eye diseases

The prevalence of eye diseases varies among different reports. In many reports, the prevalence of eye diseases (if not include refractive errors) is usually less than 5%. In Thailand, Ratanachu-ake and Untanuvatana studied the prevalence of eye diseases in school children and found the prevalence to be 3.4%. This study assumes the prevalence to be 3.4% and assumes that the children with eye diseases distribute evenly among the 60 participating schools.

2. This study assumes that there are no significant differences of students in the 60 participating schools in terms of disease prevalence and compliance to referral. (This assumption is got from the discussion with the coordinator of the SFK program.)

3. The author assumes that the students who were screen positive, whether they had eye diseases (true positive) or not (false positive), have the same response to refer (compliance).

3.4 Research methods

To get the sufficient information to perform the CEA, the following activities are needed.

- Find the sensitivity and the specificity of screening tests.
- Interview the SFK program coordinator to find out the cost of the program.

- Distribute questionnaires to the parents of the screen positive students to find the referral compliance rate, and the referral cost to the parents.
- Search for the cost to the eye care facility.
- Perform the cost-effectiveness analysis.
- Perform the sensitivity analysis

3.4.1 Sensitivity & specificity of the screening tests

The sensitivity and the specificity of the screening tests used in the school vision screening program are the key information to calculate the number of screening positive cases and also the number of students who really have eye diseases (true positive).

There are existing data on sensitivity and specificity of the vision screening tests. (Robinson, Bobier, Martin, & Bryant, 1999b; Tong et al., 2002a, 2002b) Since the screening tests used in the SFK program (visual acuity test and stereopsis test) are newly developed, there would be bias to adopt the sensitivity and specificity from other studies. The author decides to analyze the sensitivity and the specificity of the screening tests and use the information in the calculation of the cost effectiveness analysis.

To study the sensitivity and the specificity of any screening tests, first a gold standard (a test to distinguish people with disease from people without diseases) is needed. In the study, the author uses the result of ophthalmic examination to be the gold standard. The result of the ophthalmic examination reveals which person has eye disease and which person has not. The screening tests are performed in the people with and without disease. The relationship of the screening test results and the present or absent of the disease can be summarized as in the following two by two table.

Table 3.1 The 2 x 2 table for calculation of sensitivity and specificity

	Disease present	Disease absent
Test positive	a	b
Test negative	c	d

Sensitivity is defined as the proportion of people with the disease who have a positive screening test for the disease. Thus it is calculated by a/(a+c).

Specificity is defined as the proportion of people without the disease who have a negative screening test. Thus it is calculated by d/(b+d).

In the study the screening tests that are analyzed are 1) the visual acuity test, and 2) the combination of the visual acuity test and the stereopsis test.

Because the sensitivity and the specificity are the stable characteristic of the tests that would not change as long as the tests are performed in the same ways, the sample used to study the sensitivity and the specificity can be any people (one group has the disease and another group has no disease). The results can be used anywhere as long as the screening tests are performed in the same ways. (Fletcher, Fletcher, & Wagner, 1996) This study decides to use students in the SFK program for analyzing sensitivity and specificity. Because there is available space in a school participated in the program to be used for ophthalmic personnel to examine the students, the school is chosen as study site for sensitivity and specificity analysis. The cost to get ophthalmic team to examine students in a school is high so this activity is performed in only one school. Students from the selected school and other three nearby schools are randomized for the sensitivity and specificity study.

The ophthalmic team examines the students and classifies the students into students with eye diseases and students without disease. The standard ophthalmic examination is performed. The detail of examination process is as followings.

1. Visual acuity assessment.

2. External eye examination and slit-lamp biomicroscopic examination.

3. Strabismic evaluation

4. Dilated pupil using 1% tropicamide 2 times, 5 minutes apart. Another instillation of mydriatic drug is given if the pupil is less than 5 mm.

5. Fundus examination.

6. Cycloplegic refraction

After the eye examination the ophthalmologist concludes that the examined student has eye diseases or not. Students are screened by school teachers using the studied screening tests (visual acuity test and the combination of visual acuity test and stereopsis test). The ophthalmic team does not know the results of the screening tests. The results are used to create two by two tables. The sensitivity and the specificity of the screening tests are calculated.

When using the screening test in the real situation, the predictive value is important. The positive predictive value (PPV) is the probability of disease in a person with a positive (abnormal) test result.

$$\text{Positive predictive value} = \frac{\text{Sensitivity x Prevalence}}{(\text{Sensitivity x Prevalence}) + (1\text{-Specificity})(1\text{-Prevalence})}$$

3.4.2 Interview the SFK program coordinator

The author interviewed the SFK program coordinator to find out the cost information to the SFK program. The detailed information of the administrative cost, costs of the screening test kits, training cost, screening cost and screening cost are collected. Further information on the income of the participating teachers and ophthalmic nurses are asked.

3.4.3 Referral compliance and the socioeconomic characteristics of the families

In order to get the information on what the parents of the positive screen students will response if the program refers the children to eye care facilities, and how much the referral cost is to the parents the questionnaires was used. The questionnaire was developed, tested and modified until they are usable. The questionnaires are sent to the parents of the students who are positive screening to get the compliance rate for referral as well as the cost of the parents (referring cost and foregone income). The sample size and sampling technique are stated in the earlier section. The information will be used to calculate the cost effectiveness of the alternatives.

The compliance rate of the students in the alternatives (alternative 3 & 4) that refer the positive screening students to existing health care services will be obtained from questionnaire. The questionnaires will be distributed to the parents of the students through school teachers.

Sampling method & Sample size

The random sampling technique will be used. The author assumes that the schools participating in the Sight for Kids program are not different. The formula for sample size calculation is as following. (Jekel et al., 1996)

$$N = \frac{(Z_\alpha + Z_\beta)^2 \bullet 2\bar{p}(1-\bar{p})}{(\bar{d})^2}$$

The sample size is calculated for alpha error of 0.05, beta error of 0.20, expected compliance of 90% and difference of 10%. The calculated sample size is 189. The author estimates 70% response rate so at least 270 questionnaires will be distributed. Eight schools will be randomly sampling and the questionnaires will be distributed to the parents of all students who were screening positive.

Eight schools participated in the SFK program are randomly selected. The questionnaires are sent to the parents of all screen positive students in the selected schools. The parents are asked to return the questionnaires to the teachers within one week.

Referral compliance

The questionnaires ask for the age, education level, and occupation of the fathers and mothers, family size, and family income. The parents were also asked for their response if the child was referred to the eye care facilities. The choice of eye care facility was asked. (Appendix C)

The parents' answers on their referral compliance are in 3 choices (1: certainly comply; 2: not sure; and 3: certainly not comply). The "not sure" group and the "certainly not comply" group are grouped together into "non-compliance" group. The compliance rate and 95% confidence interval are calculated.

Factors related to compliance

This study would like to identify the factors related to compliance. Because the compliance and the non-compliance are the binary dependent variable, the "logit model" was used to study the factors related to the compliance. (Campbell, 2001)

Some of the variables in the questionnaires are expected to relate to the compliance. These variables are: income, father's education, mother's education, traveling time, proportion of the referral cost to income, and total referral cost to the parents.

Study on the barriers to health care facilities utilization revealed that the primary barriers are: ability to pay, perception of need, service availability, accessibility of services. (Strickland & Strickland, 1996) The ability to pay is related to the family income and the total referral cost to the parents. Since the perception of need is difficult to measure, the parents' educational level is used as a proxy. In this study, the variables are selected because the assumption that referral rate is related to family income, parents' education level.

The hypothesis of this study is that the income, father's education level, and mother's education level have negative effects to the non-compliance; the traveling time and the ratio of referral cost to the income have positive effects to the compliance. The independent factors that are significant will be included in the final model.

The logit model is as following.

$$\log_e\left\{\frac{p_i}{(1-p_i)}\right\} = C + \beta_1 INC + \beta_2 FEDU1 + \beta_3 FEDU2 + \beta_4 MEDU1 + \beta_5 MEDU2 + \beta_6 TIME + \beta_7 COST + \beta_8 PROP$$

Table 3.2 The variables in the logit model

Variable	Variables' explanation	Unit of measurement
p	Probability of compliance	
C	Constant	
INC	Family income	1,000 Baht
FEDU1	Father's education1 (secondary level = 1; else = 0)	
FEDU2	Father's education2 (certificate level or bachelor degree or post-graduation = 1; else = 0)	
MEDU1	Mother's education1 (secondary level = 1; else = 0)	
MEDU2	Mother's education2 (certificate level or bachelor degree or post-graduation = 1; else = 0)	
TIME	Traveling time to health care facility	Minutes
COST	Total referral cost to the parents	100 Baht
PROP	Proportion of referral cost to monthly family income	Percent

3.4.4 Cost calculation

This study uses societal perspective for the cost analysis. The cost of the vision screening processes until the screen positive students receive eye

examination can be divided into many parts according to the activities in each of the vision screening alternatives, as followings.

1. Administrative cost of the SFK program
2. Training cost
3. Screening cost
4. Cost of the mobile team
5. Referral cost to the parents
6. Cost of eye examination to the eye care facilities

Thus, the overall cost can be calculated as shown in the table 3.3.

Table 3.3 Shows cost in the study

Cost	Alternative 1 Combined screening tests + Mobile team	Alternative 2 VA test + Mobile team	Alternative 3 Combined screening tests + Refer	Alternative 4 VA test + Refer
Cost of the program Administrative cost Training cost Screening cost Mobile team				
Cost of the parents Referring cost Income foregone				
Cost of health facility Eye examination cost				
Total				

The costs of training, screening, ophthalmic examination by the mobile team, and administrative cost are mainly to the SFK program. The cost of the mobile team composes of the traveling cost and the wages of the mobile team personnel. This is varied according to the number of screening positive students to be examined. The information of the mentioned costs is obtained from the interview with the program coordinator.

The costs of taking the referred children to see ophthalmic personnel (compliance) from the parents' perspective will be asked from the parents using questionnaire.

Administrative cost.

The SFK program is run by a non-government organization (NGO). The cost includes the cost actually incurred to the program as well as the cost absorbed by the NGO. The cost is estimated for the whole 3-year period of the SFK program. The cost of the 2nd and the 3rd year is converted into the present value of the first year. The present value is calculated using the following formula. (Drummond et al., 1997)

$$P = \sum F_n (1+r)^{-n}$$

(P = present value; F_n = future cost at year n; r = annual discount rate)

The author uses discount rate of 3% according to Boardman et al. (Boardman, Greenberge, Vining, & Weimer, 1996) The length of time of useful life of equipments was used according to the American Hospital Association. (American Hospital Association, 1978) The straight line depreciation method was used.

Training cost.

The SFK program already has completed the training that was planned. There were 6 training sessions for 268 school teachers from the participating 60 schools. The training cost was calculated from the real cost that incurred. The training cost composes of the cost of training materials, rent for training place, traveling cost and compensation for the trainers and the administrative staffs.

Screening cost.

The screening cost composes of the cost of the screening kits and the time cost of the teachers who do the screening.

After the training, the teachers perform the vision screening in the 87,534 students in the 60 participating schools. This is an ongoing process and will be completed within the 3-year program period. Because of this the author finds the average cost of screening per student (according to screening tests used) and calculates the total cost of the screening for each alternative.

Cost of mobile team.

The cost of the mobile team is calculated as cost per examined student. The data is derived from the 2 sessions of mobile team that was already performed by the program.

Cost of eye care facility

Cost of the eye care facility is used in the calculation. This study is not intended to find out the cost of eye care facility. The secondary data of the cost will be used.

3.4.5 Cost effectiveness analysis

Alternatives

There are four alternatives being compared in this study. The alternatives are different in the screening tests used and also in the management procedures so that the positive screening students receive eye examination by ophthalmic personnel.

Screening Tests

The screening tests are either visual acuity test or the combination of visual acuity test with stereopsis test.

Management Procedures for the screen positive students

The students whose screening results are positive will be examined by ophthalmic personnel either by mobile team to the schools or by referral to the existing health services nearby.

In summary, the screening tests and the management procedures in each alternative is as in the following table.

Table 3.4 Shows the screening tests and diagnostic eye care delivery methods used in each alternative

	Eye care service	
	Mobile team	**Refer to hospital**
VA + stereopsis test	Alternative 1	Alternative 3
VA test	Alternative 2	Alternative 4

The cost effectiveness of each alternative is calculated using the hypothetical context of the 60 schools participated in the Sight for Kids program to find out if the program chooses any alternative, what will be the cost effectiveness.

The effectiveness is defined as children with visual abnormalities who was screened and was examined by ophthalmic personnel.

In summary, the four different alternative interventions are shown in the next figure. Using the target of 60 schools participated in the Sight for Kids program, the hypothetical cost and effectiveness of each alternative can be calculated. These alternatives have different costs because each alternative requires different amount of resources. They also have different effectiveness because different screening tests will result in different number of screen positive students. Moreover, the alternatives that refer the screen positive students to the hospital (alternative 3 and 4) will depend on the probability of compliance of the parents.

Effectiveness calculation

The cost effectiveness analysis is calculated to find out if all students in the Sight for Kids program are screened and are examined by the four alternatives, what the cost effectiveness will be. All students are screened by teachers using different tests according to the chosen alternative. The proportion of positive screening occurs by chance (the probabilities depend on the screening test used). For the alternatives in which the program provides the mobile team (alternative 1, and 2), every screening positive student will be examined by ophthalmic personnel. For the alternatives in which the screening positive students are referred to hospital, the proportion of these students that will be examined by ophthalmic personnel depends on referral compliance rate. The effectiveness is defined as

children with visual abnormalities who was screened and was examined by ophthalmic personnel. From this, we will see that the costs and the effects are different among the alternatives. The cost and effectiveness for each alternative will be calculated and compared. To calculate the effectiveness, the information of the percentage the parents who are willing to take the screening positive students to the hospital (compliance rate) is needed.

After the information on sensitivity, specificity and compliance rate is known, it is possible to calculate the effectiveness (the number of students with eye diseases who have positive screening and receive eye examination by ophthalmic personnel) of the alternatives.

Since the cost and the effectiveness of each alternative are now calculated, it is possible to calculate the cost-effectiveness ratio (CER) of each alternative. The CER of each alternative can be compared. The alternative with lower CER value is better because this means that the alternative uses less resource per one case of effectiveness.

Table 3.5 Shows the process to calculate the effectiveness

	A 1 Combined screening tests + Mobile team	A 2 VA test + Mobile team	A 3 Combined screening tests + Refer	A 4 VA test + Refer
Total number of students				
Number of students who are screened positive				
Compliance to refer				
Number of students who had eye examination				
Effectiveness (number of students with eye diseases and had eye examination)				
False negative (number of students who had eye diseases but not received eye examination				

3.4.6 Sensitivity Analysis

Sensitivity analysis is performed to test the influenced of uncertainty in the model. Only a single item is changed from its baseline value while other parameters are fixed. The author performs sensitivity analysis for prevalence changes, sensitivity & specificity changes, discount rate changes, or compliance rate changes to see the changes in the cost effectiveness ratios in the four alternatives.

3.5 Summary of Data Collection

To summarize the data collection (outcome measures, data source, measurement processes, and formulae), the processes of data collection was shown in table 3.6.

Table 3.6 Shows summary of data collection

Outcome Measure	Data Source	Measurement Processes	Note
Sensitivity of screening tests	Primary data	Perform complete eye examination in a group of students to identify which students have eye diseases. Determine the result of screening tests in students who have eye diseases.	Sensitivity = students who have eye diseases and screen positive by total students who have eye diseases
Specificity of screening tests	Primary data	Perform complete eye examination in a group of students to identify which students do not have eye diseases. Determine the result of screening tests in students who do not have eye diseases.	Specificity = students who do not have eye diseases and screen negative by total students who do not have eye diseases
Prevalence of eye diseases in school children	Secondary data	Use data from school survey for eye diseases	
Number of students who are screen positive	Calculation		Calculate number of students who have eye diseases and who have not eye diseases (using the prevalence). Then calculate number of screen positive student using the sensitivity and specificity data.

Outcome Measure	Data Source	Measurement Processes	Note
Referral compliance rate	Primary data	Send questionnaires to parents of screen positive students.	Referral compliance rate = number of parents who will certainly take their screen positive child to eye care facility by total parents answering the questionnaires.
Number of children receiving eye examination	Calculation		In the alternatives that provide mobile team, the number of children receiving eye examination is total number of screen positive students. In the alternatives that refer the screen positive students to eye care facilities, the number of children receiving eye examination is total number of screen positive students multiply by referral compliance rate
Effectiveness (students with eye diseases who were screened and receiving eye examination)	Calculation		Calculate number of students with eye diseases who were screen positive and receiving eye examination)
Students who have eye diseases but not receiving eye examination	Calculation		Number of students who have eye diseases minus number of effectiveness

Outcome Measure	Data Source	Measurement Processes	Note
Administrative cost	Primary data	Interview the SFK program coordinator	
Training cost	Primary data	Interview the SFK program coordinator	
Average screening cost	Primary data	Interview the SFK program coordinator	
Total screening cost	Calculation		Total screening cost = average screening cost multiply by total number of students
Average cost of mobile team	Primary data	Interview the SFK program coordinator	
Total cost of mobile team			Total cost of mobile team = average cost of mobile team multiply by number of students receiving examination by mobile team
Referral cost to the parents	Primary data	Questionnaires	
Income foregone	Primary data	Questionnaires	
Eye examination cost to the health care facility	Secondary data		
Cost-effectiveness ratio	Calculation		Cost-effectiveness ratio = total cost divided by effectiveness