EFFICIENCY EVALUATION OF HERBAL PRODUCTION IN COMMUNITY HOSPITALS: A CASE STUDY OF U-THONG HOSPITAL, SUPHAN BURI PROVINCE

NATTAYA PANSANG

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE IN PHARMACY
(PHARMACY ADMINISTRATION)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2004

ISBN 974-04-5291-4

Thesis

Entitled

EFFICIENCY EVALUATION OF HERBAL PRODUCTION IN COMMUNITY HOSPITALS: A CASE STUDY OF U-THONG HOSPITAL, SUPHAN BURI PROVINCE

Nattaya Pansang

Ms.Nattaya Pansang
Candidate

Assoc.Prof.Arthorn Riewpaiboon,
Ph.D. (Pharmacy)
Major-Advisor

Assoc.Prof.Cha-onsin Sooksriwong,
Dr.PH. Public Health Administration)
Co-Advisor

Assoc.Prof.Rassmidara Hoonsawat,
Ph.D. (Physics)
Dean
Faculty of Graduate Studies

Prof.Ampol Mitrevej, Ph.D. (Pharmaceutics)
Chair
Master of Science in Pharmacy Programme in
Pharmacy Administration
Faculty of Pharmacy

Thesis
Entitled

EFFICIENCY EVALUATION OF HERBAL PRODUCTION IN COMMUNITY HOSPITALS: A CASE STUDY OF U-THONG HOSPITAL, SUPHAN BURI PROVINCE

was submitted to the Faculty of Graduate Studies, Mahidol University
for the degree of Master of Science in Pharmacy (Pharmacy Administration)
on
September 28, 2004

Ms.Nattaya Pansang
Candidate

Assoc.Prof.Arthorn Riewpaiboon,
Ph.D. (Pharmacy)
Chair

Assoc.Prof.Cha-onsin Sooksriwong,
Dr.PH. (Public Health Administration)
Member

Mr.Thanaphol Virasa,
Ph.D. (Management of Technology)
Member

Ms.Usa Chaikledkaew,
Ph.D. (Pharmaceutical Economics and Policy)
Member

Assoc.Prof.Rassmidara Hoonsawat.
Ph.D. (Physics)
Dean
Faculty of Graduate Studies
Mahidol University

Prof.Ampol Mitrevej, Ph.D. (Pharmaceutics)
Dean
Faculty of Pharmacy
Mahidol University

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude and deep appreciation to Associate Professor Dr. Arthorn Riewpaiboon, my major-advisor, who gave me the valuable advice, guidance, kindness and encouragement throughout my study. Without his willing support, this work would not be possible.

Also, I would like to express my sincere gratitude to Associate Professor Dr. Cha-onsin Sooksriwong, my co-advisor, for her kind suggestion, attention and encouragement.

I am very grateful to U-thong Hospital in Suphan Buri that allowed me to undertake this study. Additionally, I also wish to express my deepest thanks to all participants in the hospital for their assistance and facilitation in data collection.

My appreciation and grateful are also expressed to all of my lecturers who have taught and shared the knowledge and their experiences especially in Pharmacy Administration Program.

My deepest thanks are extended to all of my friends for their help and understanding. Finally, my special thanks are given to my family for their great patience, encouragement and understanding that inspired me to reach my goal.

Nattaya Pansang

EFFICIENCY EVALUATION OF HERBAL PRODUCTION IN COMMUNITY HOSPITALS: A CASE STUDY OF U-THONG HOSPITAL, SUPHAN BURI PROVINCE

NATTAYA PANSANG 4536847 PYPA/M

M.Sc. in Pharm. (PHARMACY ADMINISTRATION)

THESIS ADVISORS: ARTHORN RIEWPAIBOON, Ph.D. (PHARMACY), CHA-ONSIN SOOKSRIWONG, Dr.PH. (PUBLIC HEALTH ADMINISTRATION)

ABSTRACT

This study was a cross-sectional descriptive research. The objective was to evaluate the efficiency of herbal production in community hospitals based on a production unit perspective. The data of U-thong Hospital in the fiscal year 2003 was used as a case study. The efficiency was evaluated by conducting cost-benefit analysis, payback period determination, and productivity evaluation. Cost-benefit analysis as a technique of economic evaluation was used to measure the worth of the program. The standard method was employed to analyze production cost covering both direct and indirect costs, while benefits were revenues from sales. To evaluate productivity, the productivity index formulated by the Thailand Productivity Institute was used to evaluate the ability on converting inputs into outputs by comparing with the average of small modern drug industries.

Results revealed that 76 herbal products were produced in the fiscal year 2003. The cost of herbal production was 2,322,521.92 baht, and the revenue was 2,422,848.00 baht. As a result, net benefit was 100,326.08 baht, and benefit to cost ratio was 1.04. The payback period was 2 years and 6 months. As for productivity evaluation, it was found that the herbal production was a labor intensive industry and the ability to use resources for generating profit was equal to the average obtained from private industry. Regarding sensitivity analysis, discount rates which varied to 0% and 3% did not change the net benefit to negative value. However, the 10% increased prices of materials used in production process resulted in negative net benefit. For the payback period, ±10% variation of the number of services which were applied to production quantity affected only a one-month change while the assumption on the herbal production as a new investment in the fiscal year 2003 resulted in a payback period of 6 years and 5 months.

These findings indicated that herbal production was worthwhile. The return period of the program investment was rather short. Moreover, the ability on generating profit was equal to other manufacturers. However, before generalizing the results of this study, there were two notes of concern. The first is that this production unit did not reach GMP standards. Another is that the expense of marketing activities did not occur at this study site.

KEY WORDS: EFFICIENCY / COST-BENEFIT ANALYSIS / PRODUCTIVITY / PAYBACK PERIOD / EVALUATION / HERBAL PRODUCTION / COMMUNITY HOSPITAL

83 pp. ISBN 974-04-5291-4

การประเมินประสิทธิภาพของการผลิตผลิตภัณฑ์สมุนไพรในโรงพยาบาลชุมชน: กรณีศึกษาโรงพยาบาลอู่ทอง จังหวัดสุพรรณบุรี (EFFICIENCY EVALUATION OF HERBAL PRODUCTION IN COMMUNITY HOSPITALS: A CASE STUDY OF U-THONG HOSPITAL, SUPHAN BURI PROVINCE)

ณัฐญา ปานสังข์ 4536847 PYPA/M

ภ.ม. (บริหารเภสัชกิจ)

คณะกรรมการควบคุมวิทยานิพนธ์ : อาทร ริ้วไพบูลย์, Ph.D. (Pharmacy),
ชะอรสิน สุขศรีวงศ์, Dr.PH. (Public Health Administration)

บทคัดย่อ

การศึกษาครั้งนี้เป็นการวิจัยเชิงพรรณนาแบบตัดขวาง เพื่อประเมินประสิทธิภาพของการผลิตผลิตภัณฑ์สมุนไพรในโรงพยาบาลชุมชนในมุมมองของหน่วยผลิต ในการศึกษาใช้ข้อมูลของโรงพยาบาลอู่ทอง จังหวัดสุพรรณบุรี ปีงบประมาณ 2546 ทำการประเมินประสิทธิภาพโดยการวิเคราะห์ต้นทุน-ผลได้ การคำนวณหาระยะเวลาการคืนทุน และการประเมินผลิตภาพในการผลิต ในการวิเคราะห์ต้นทุน-ผลได้ เพื่อประเมินความคุ้มค่าของโครงการนั้น ต้นทุนของการผลิตคำนวณโดยวิธีวิเคราะห์ต้นทุนแบบมาตรฐานซึ่งครอบคลุมทั้งต้นทุนทางตรงและต้นทุนทางอ้อม สำหรับผลได้คำนวณจากรายได้ที่เกิดจากการจำหน่ายผลิตภัณฑ์ ส่วนการประเมินผลิตภาพใช้ดัชนีชี้วัดที่จัดทำโดยสถาบันเพิ่มผลผลิตแห่งชาติโดยทำการเปรียบเทียบกับค่าเฉลี่ยของอุตสาหกรรมการผลิตยาแผนปัจจุบันขนาดเล็ก

ผลการศึกษาพบว่า ในปีงบประมาณ 2546 โรงพยาบาลอู่ทองมีการผลิตผลิตภัณฑ์สมุนไพรทั้งสิ้น 76 รายการ คิดเป็นต้นทุนทั้งสิ้น 2,322,521.92 บาท และมีรายได้ 2,422,848.00 บาท ทำให้มีผลได้สุทธิเท่ากับ 100,326.08 บาท และสัดส่วนผลได้ต่อต้นทุนเท่ากับ 1.04 มีระยะเวลาในการคืนทุนคือ 2 ปี 6 เดือน ส่วนการประเมินความสามารถในการผลิตพบว่าการผลิตผลิตภัณฑ์สมุนไพรมีลักษณะเป็นอุตสาหกรรมประเภทใช้แรงงานเป็นหลักและมีความสามารถในการใช้ทรัพยากรเพื่อสร้างผลกำไรเท่ากับค่าเฉลี่ยของอุตสาหกรรมการผลิตยาแผนปัจจุบันภาคเอกชน สำหรับการทดสอบความไวพบว่าการเปลี่ยนแปลงอัตราการปรับลดเป็น 0% และ 3% ไม่มีผลทำให้ผลได้สุทธิติดลบ แต่การเพิ่มขึ้น 10% ของราคาวัตถุดิบที่ใช้ในกระบวนการผลิตมีผลทำให้ผลได้สุทธิติดลบ สำหรับระยะเวลาการคืนทุนพบว่าการเปลี่ยนแปลงของจำนวนครั้งที่ให้บริการที่ ±10% ทำให้ระยะเวลาการคืนทุนเปลี่ยนแปลงเพียง 1 เดือน แต่เมื่อสมมติว่าการผลิตสมุนไพรเป็นการเริ่มลงทุนใหม่ในปีงบประมาณ 2546 พบว่ามีระยะเวลาการคืนทุน 6 ปี และ 5 เดือน

จากการศึกษาครั้งนี้ทำให้ทราบว่าการผลิตผลิตภัณฑ์สมุนไพรนั้นเกิดความคุ้มค่า มีระยะเวลาในการคืนทุนที่ค่อนข้างสั้น และมีความสามารถในการสร้างผลกำไรเท่ากับผู้ผลิตรายอื่น อย่างไรก็ตามในการนำผลการศึกษาในครั้งนี้ไปใช้กับที่อื่น มีบางประเด็นที่ต้องตระหนักถึงคือหน่วยผลิตที่ทำการศึกษานี้ยังไม่เป็นไปตามมาตรฐานกระบวนการผลิตที่ดี (GMP) และไม่มีค่าใช้จ่ายด้านการตลาด

83 หน้า ISBN 974-04-5291-4

CONTENTS

CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

Thai Traditional Medicine (TTM) system, ancient wisdom of Thai society, has increased popularity due to the limitation of modern medicine system to solved health problem and the rising of health care expenditure. Thus, the use of herbal drug that is major practice of TTM, has been promoted by the government since the Fourth Public Health Development Plan. Many developments were conducted. In health care facilities, TTM was integrated into health care services. In the organization level, several departments were established for developing TTM. In the policy level, herbal drugs were included in the National List of Essential Drugs 1999. Afterward, herbal drug was set up to be used not less than 3 percent of the total drug expense in general hospitals and 5 percent in community hospitals in the Ninth Public Health Development Plan.(1-7) At the end of the year 2002, among the public hospitals, TTM has been implemented in 525 hospitals. Of these, 157 hospitals produced herbal drugs.(8)

In 2001, the government of Thailand initiated the Universal Health Care Coverage (UC) or 30 Baht Scheme. This scheme makes a lot of changes to health care finance. The budgeting systems for health care facilities have been changed from line item budgeting allocated by the Ministry of Public Health (MOPH) to capitation system allocated by the National Health Security Office (NHSO). Under the new system, health care facilities would be affected by the reduction of revenue from out-of-pocket of patients via fee-for-service system.(9) In particular, TTM including herbal drug treatment has been also incorporated into the 30 Baht Scheme. Therefore, some health care facilities are still uncertain about the TTM implementation due to its worth.(10) As the consequence, the Universal Health Care Coverage Committee has declared the reimbursement of TTM services for the referred case to motivate utilization.(11)

For this reason, TTM services have to be evaluated their efficiency especially in herbal production. In the past, the study of cost analysis of herbal products at ChaoPhya Abhaibhubejhr Hospital revealed that the herbal production was profitable when some parts of costs were subsidized by the government.(12) However, this is the study in a regional hospital. In the community hospitals, they have never been studied.

U-thong Hospital is a 90-bed community hospital under the Ministry of Public Health (MOPH). TTM has been implemented since 1991. It is integrated into health care services in the hospital. The activities include promotional activities, herbal production, and herbal drug treatment. Regarding herbal production, it has been established together with TTM. At the start, some herbal products were produced to support health services in the hospital. Then herbal production has been developed continuously. Until the present, many herbal product items are produced not only for using in the hospital but also for selling directly to customers and other health care facilities. In addition, the herbal raw material center, which is supported by the National Institute of Thai Traditional Medicine, has been established to support raw material to herbal production unit.(13, 14) Therefore, there are many benefits generated from herbal production. They are classified as direct and indirect benefits, direct benefits are revenue from sales and savings from substitution of modern drugs. For indirect benefits, they are creating good image of the hospital, education advantage as a training center for education institutes, and generating incomes to community. It is also as a part of research and development of traditional medicine in Thailand.

Under the 30 Baht Scheme, the financial status of the hospital has been impacted. Therefore, hospital management has to be improved. Efficiency on resource used of services should be identified. One of the important services is herbal production, which is established to support herbal drug utilization according to the government policy. However, the efficiency has never been assessed. For this reason, the results from this study can be used to provide beneficial information for the hospital administrators to make decision on the efficiency of resource utilization.

Moreover, this study will be an example to evaluate the efficiency of herbal production in other community hospitals.

Objectives

General objective

The general objective was to evaluate the efficiency of herbal production in community hospitals based on production unit perspective.

Specific objectives

There were three specific objectives as the followings:

1. To analyze cost and benefit of herbal production at U-thong Hospital, Suphan Buri Province.
2. To determine the time required to recover initial cost of herbal production at U-thong Hospital, Suphan Buri Province.
3. To evaluate the productivity of herbal production at U-thong Hospital, Suphan Buri Province.

Study Location

The study location was the production unit at U-thong Hospital.

Scope of Study

This study was based on production unit perspective. Costs and benefits were calculated based on resource consumption and output production in the fiscal year 2003 (October 2002 – September 2003). Costs included direct and indirect costs. For benefits, only direct benefit, i.e. revenue from sales, was included.

Expected Outcomes and Benefits

The results of this study can be used as the beneficial information for hospital administrators to achieve efficient resource management. In addition, this study will be an example to evaluate the efficiency of herbal production in other community hospitals.

Definition of Terms

Efficiency

In economics, efficiency is defined as the highest benefits generated from using limited resources.(2)

Cost-benefit analysis

Cost-benefit analysis is a type of economic evaluation. Costs and benefits which are measured in monetary terms, are compared in form of net benefit (total benefits – total costs) and benefit to cost ratio (total benefits/total costs).(15)

Cost center

A cost center may be a department or a grouping within a department. There is recording system on resource consumed and output produced.(16)

Transient cost center (TTC)

A cost center that provides supporting to other cost centers. Direct cost of this cost center will be allocated to other cost centers.(16)

Absorbing cost center (ACC)

A cost center that receives costs allocated from transient cost center.(16)

Micro-costing method

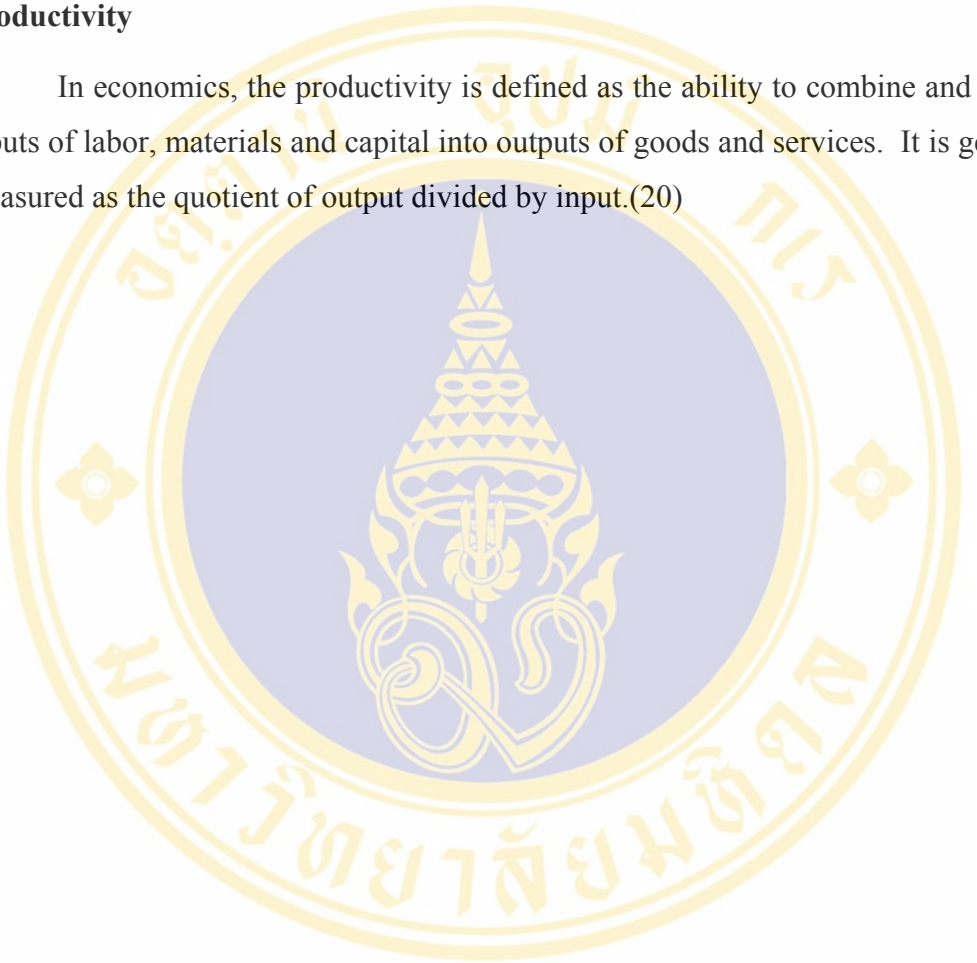
There are two meanings for micro-costing method. Firstly, micro-costing is used to determine cost of treatment from each type of medical services consumed. This method provides cost of treatment of individual patient.(17) Secondly, micro-costing is used to allocate cost from cost center to individual outputs or services. The concept of this method is to determine direct cost of each service. Then indirect cost of services (the result of full cost subtracted by sum of total direct cost of services) is allocated to each service by suitable criteria.(18) The latter was applied to the study.

Payback period

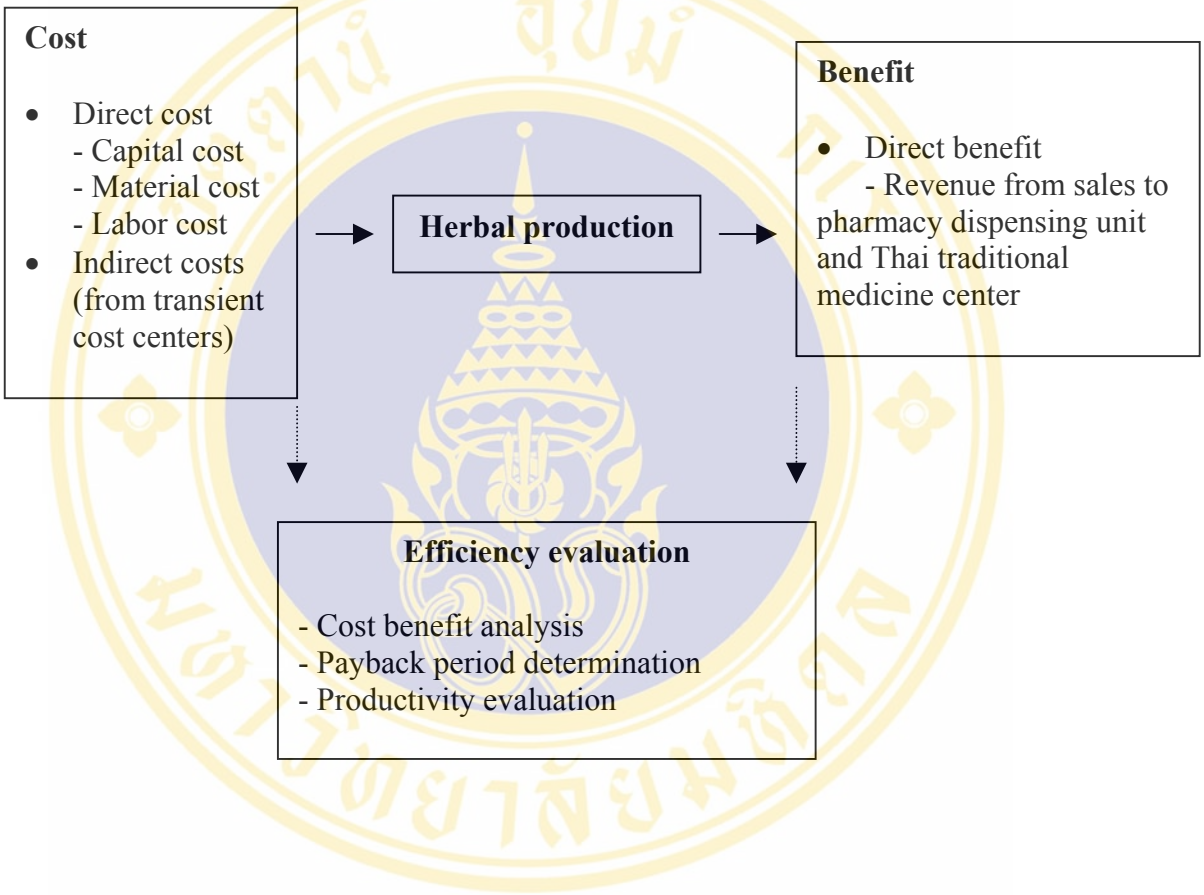
The payback period is the time required for a project's total benefits to exceed its total costs.(19)

Productivity

In economics, the productivity is defined as the ability to combine and convert inputs of labor, materials and capital into outputs of goods and services. It is generally measured as the quotient of output divided by input.(20)



Conceptual Framework



CHAPTER 2
LITERATURE REVIEW

1. The Situation of Herbal Drug Utilization in Thailand

The official promotion of medicinal plant utilization has been started since the Fourth Public Health Development Plan (1977-1981). In this plan, some medicinal plants were included in the primary health care program. In 1981, the National Drug Policy was extended to cover the use of medicinal plants focusing on the research on the essential raw materials for herbal drug manufacturing. The ultimate goal is self-reliance by using natural resource in the country.

Later on, the Fifth Public Health Development Plan (1982-1986), the MOPH started a pilot project on promotion of herbal utilization in 1000 villages of 25 targeted provinces. This project was financial supported by the UNICEF. The activities included research support, information disseminating, and providing herbal seedling. Then, there was a following project aimed to promote herbal utilization in the hospitals. It was the Project of Basic Health Service Making Use of Herbs. This project was supported by the German Agency for Technical Cooperation (GTZ). It was conducted in 5 community hospitals and focused on 5 medicinal plants. This project revitalized the herbal drug utilization. It integrated herbal drugs into health care services.

After that, the promotion of herbal drug utilization was continued to the Sixth Public Health Development Plan (1987-1991). Some herbal drugs were incorporated into the Household Drug List.(3) The herbal development was continued throughout the Seventh Public Health Development Plan (1992-1996). During this plan, the National Institute of Thai Traditional Medicine was established to be the center for developing, coordinating, supporting and cooperating the activities related to Thai traditional medicine.(1)

During the Eighth Public Health Development Plan (1997-2001), the attention of herbal drug utilization was extended continuously. Starting by the establishment of the Medicinal Plant Research Institute in 1997, this center is managed under the Department of Medical Sciences, and plays its roles as a center for analyzing, researching, and developing the use of medicinal plants.(4) Later, some herbal drugs were incorporated into the National List of Essential Drugs 1999 in order to increase herbal drug utilization in all levels of the health service facilities.(5) During the same time, the Act on Protection and Promotion of Traditional Thai Medicinal Intelligence, B.E. 2542 was enacted in the year 1999 in order to facilitate TTM.(21)

Currently, the Ninth Public Health Development Plan (2002-2006) includes supporting and developing of TTM as one of the goals. The budget on TTM has increased. The public and private health care facilities are supported in order to accomplish the use of standard herbal drugs. In addition, herbal drug use is planed to be not less than 3 percent of the total drugs in terms of expenditure in general hospitals and 5 percent in community hospitals. (6) In 2002, the Department for Development of Thai Traditional and Alternative Medicine was established. It also increased the potentiality to TTM.(7) At the end of 2002, there were herbal production in 24 provincial hospitals and 133 community hospitals.(8) In the private sector, the study of Riewpaiboon showed that total consumption of herbal products through drugstores in Thailand was estimated at 2,241 million baht in the year 2003.(22)

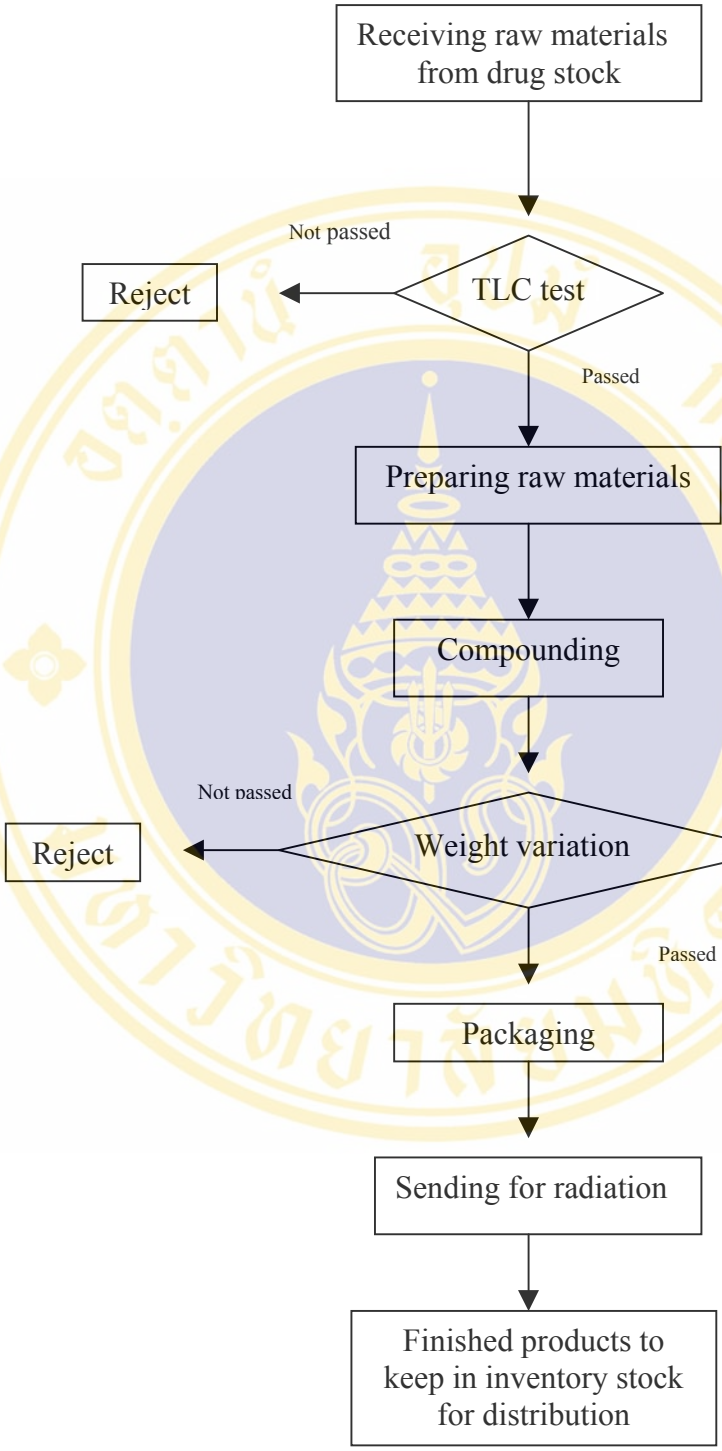
At last, trend of herbal utilization has increased together with the continuously promotion from the government. Specifically, herbal drug production in the public hospitals has been supported.

2. Herbal Production in U-thong Hospital

Herbal production unit has been established together with TTM services since 1991. In the beginning, some herbal products were produced to support health services in the hospital. Afterward, herbal production has been supported and developed continuously. Nowadays, there are many herbal product items, which are produced for using in the hospital and for selling directly to customers and other health care facilities. In addition, the herbal raw material center, which is supported by the

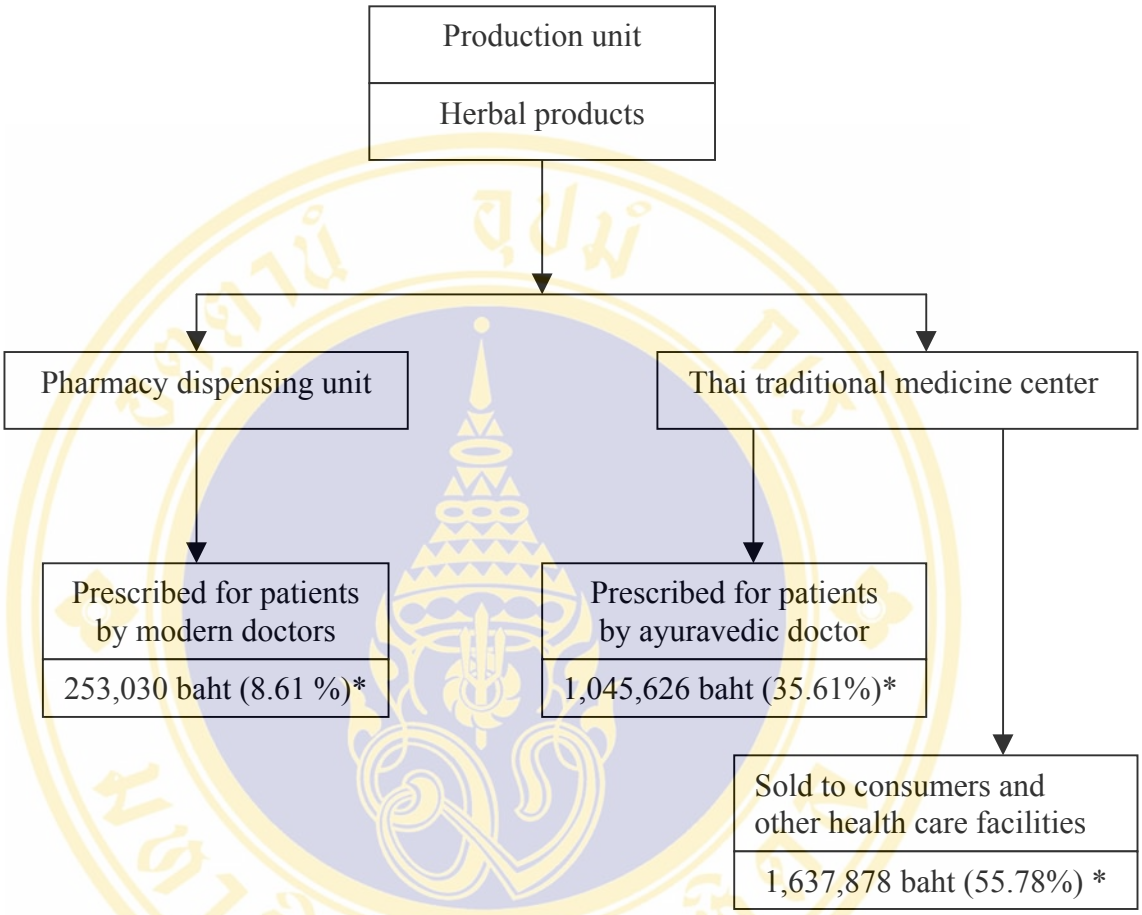
National Institute of Thai Traditional Medicine, has been established to support raw material to herbal production unit.(14)

There were 76 herbal product items produced in the fiscal year 2003. Most of products were herbal drugs whereas the remainders were cosmetics. The process of herbal production is shown in figure 1. It consisted of production and quality control process. For the customers of herbal production, they were pharmacy dispensing unit and Thai tradition medicine center. Most of products were distributed to Thai traditional medicine center for serving the patients in the center, and selling to customers and other health care facilities.(13, 14) The customer channels are shown in figure 2.



TLC = Thin-layer chromatography

Figure 1 Process of herbal production



(* The data from the report of Thai traditional medicine center in fiscal year 2003)

Figure 2 Customer channels of herbal products

3. Economic Evaluation

Economic evaluation is formally defined as the comparison of cost and consequences of two or more alternative courses of action.(2, 17) Costs are the resources consumed to perform an activity or implement a decision, while consequences are the outcomes of that action or decision. Economic evaluation assesses efficiency on the relationship between outputs (consequences) and inputs (costs). There are four methods as the followings:

1. Cost-minimization analysis (CMA)
2. Cost-benefit analysis (CBA)
3. Cost-effectiveness analysis (CEA)
4. Cost-utility analysis (CUA)

The method aimed to answer the question " Is the program worthwhile? ", is cost-benefit analysis.(23)

3.1 Cost-benefit analysis (CBA)

CBA is a type of economic evaluation that measures the outcomes in monetary terms. The results are presented in form of net benefit (NB) or benefit to cost ratio (BCR). The goal of analysis is to identify whether a program's benefits exceed its costs. A positive net benefit indicates that a program is worthwhile. Cost-benefit analysis can be conducted for a single or multiple programs to provide foundations for decision making to achieve the desired objectives.(15, 17, 24) The NB and BCR will be described as the followings:

1) Net Benefit (NB)

The NB is calculated by subtracting benefits with costs. If the NB is greater than zero, the program is worthwhile

2) Benefit to Cost Ratio (BCR)

Like NB, BCR provides direct relationship between benefits and costs of program and uses this relationship to decide whether a particular program is good investment. In this method, the ratio is simply the total benefits from a program divided by the total costs, if BCR exceeds 1 indicates the benefits exceed the costs, and hence is a good investment according to this criterion.

3.1.1 Cost aspect

Cost is the value of resources used in production.(18, 25) Resources used for health care services can be classified in several ways such as classified by input (capital cost and recurrent cost), classified by activity (direct cost and indirect cost), and classified by cost behavior (fixed cost, variable cost, and semi fixed cost).

3.1.1.1 Process of cost analysis (16, 18, 26)

Costs of producing medical services in the hospital are complicated due to each unit produces various different outputs. Moreover, some units are supported by other units. In general, there are five steps in unit cost analysis.

1) Organization analysis and cost center classification

Structure of the hospital organization is examined and objectives of cost analysis are defined. Then, the hospital structure is classified in terms of cost centers. Cost center is the unit producing its own outputs. There are more than one dimension of cost center categorization. Based on the concept of cost allocation, all cost centers are classified into two groups as Transient cost center (TCC) and Absorbing cost center (ACC).

2) Direct cost determination

Direct cost of each cost center is composed of capital cost, labor cost, and material cost.

2.1) Capital cost (17, 27, 28)

Capital cost covers capital assets required by the program; generally equipment, buildings, and land. It represents an investment in an asset which is used over time. Most assets, such as equipment and buildings, depreciate with time. On the other hand, land is non-depreciable asset because it maintains its value. There are two components.

2.1.1) Depreciation cost

Depreciation is defined as the amount of the capital that is used-up in one year. The simplest approach to depreciation is to assume that the services from the capital item are divided equally over the useful life of the capital item, knows as straight-line depreciation. There are two main approaches of the depreciation cost calculation.

a) Accounting-based approach

This approach calculates depreciation cost on the basis of an asset's original purchase price divided by useful life.

$$\text{Average annual depreciation cost} = \frac{\text{Original purchase price}}{\text{Useful life (years)}}$$

b) Economic-based approach

This approach may be called equivalent annual depreciation cost. It automatically incorporates both the depreciation aspect and the opportunity cost of un-depreciated part of the capital items.

Equivalent annual cost = Current price/ Annuity factor

Current price = Original price X Inflation adjustment factor

$$\text{Inflation adjustment factor} = \frac{\text{Price from Consumer Price Index table of the current year}}{\text{Price from Consumer Price Index table of the year of first using}}$$

$$\text{Annuity factor} = [1 - (1+r)^{-n}]/r$$

n = working year

r = discount rate

2.1.2) Opportunity cost

This is clearly seen in the case of land. An investment in non-depreciable land will return the original capital sum when sole, there is still a "cost". This cost is calculated as the lost opportunity to invest the sum in some other venture yielding positive benefits. It is usually valued by calculating the interest of the value

of land based on 12-month fixed interest rate. On the other hand, the opportunity cost of land can be valued as the land rental.

2.2) Labor cost

Labor cost is composed of salary, wage, overtime (OT), and fringe benefits. For persons who work in more than one department, labor costs were distributed to those cost centers, based on working time proportions.

2.3) Material cost

Material cost is cost of materials that were used and exhausted by each cost center in the study period. All materials are separated into two groups.

2.3.1) Materials collected according to the actual consumption of cost centers.

2.3.2) Materials unable to be collected the actual consumption of cost centers. They are distributed to the related cost centers, based on suitable criteria.

3) Indirect cost allocation

Cost allocation is a method that costs are transferred from all transient cost centers (TCCs) to absorbing cost centers (ACCs). This transferred cost is called indirect cost. Processes for indirect cost allocation include allocation criteria selection and allocation method.

Allocation criteria are the criteria that are used to find proportions for cost allocation from all TCCs to ACCs. For cost centers that produce more than one product, it should use combined allocation criteria for more correct cost allocation.

Cost allocation method is the method that is used to allocate cost from TCCs to ACCs by using the allocation proportion. There are four methods: direct distribution method, step-down method, double distribution method, and simultaneous equation method. The simultaneous equation method is most accurate. Each cost center will simultaneously allocate and receive cost until it reaches the equilibrium. This method

uses mathematics technique (matrix), calculated by computer software, for solving the equations and finding the cost allocated from TCCs.

4) Full cost calculation

After indirect costs have been determined, full cost of ACC is calculated from the summation of total direct costs and indirect costs.

5) Unit cost calculation

A unit cost is a kind of simple average cost per unit of output. It can be calculated by average method.

Unit cost = Total cost / quantity

In case of cost centers that produce various different outputs or services, unit cost is calculated, so-called departmental allocation, by many methods i.e. micro-costing, ratio of cost to changes, hourly rate method, surcharge method, per-diem method, and relative value unit. Micro-costing is generally most accurate. The concept of this method is to determine direct cost of each service. Then indirect cost of services (the result of full cost subtracted by sum of total direct cost of services) is allocated to each service by suitable criteria.

3.1.2 Benefit aspect (2, 29-31)

Benefits are the value of a program, a synonym for output. They are classified in several ways as the followings:

1) Internal and external benefits

Internal benefits are benefits that are occurred directly or indirectly to the program. Whereas, external benefits are benefits that involuntary received by others for which they pay nothing.

2) Direct and indirect benefits

Direct benefits are defined as an increased value of output associated with the program. The most common direct benefits are increase of quantity of

products in industry. For indirect benefits, they are the benefits that are occurred beyond the goal of the program.

3) Tangible and intangible benefits

Tangible benefits are benefits that can be measured in their own terms. While intangible benefits cannot be measured i.e. prestige, human life, and public recreation facilities.

In valuing benefits, all benefits have to be evaluated in monetary terms. In case of financial analysis, benefits are computed by multiplying output quantity by their market price. In the same way, benefit in terms of economic analysis can be calculated by the same method, if market price does not reflect to the scarcity, shadow price or accounting price can be used to replace it. Given the difficulties in attaching money values of intangible benefits, the willingness to pay approach is often used.

4. Payback period (19, 32)

The payback period is defined as the time required for a project's total benefits to exceed its total costs. At that time, the project can be said to have "paid back" its initial cost, hence the name payback period. For some applications, there is considerable intuitive appeal to this concept since it allows projects to be judged by how rapidly they pay off.

In calculating the payback period, the discounted cash flows (benefits subtracted by costs) are summed until a positive result is obtained.

$$\sum_{t=0}^{p} \frac{Xt}{(1+r_t)^t} \geq 0$$

p is the time needed to reach this positive sum

Xt is cash flows in period t

r_t is discount rate for period t

However, there are both strong and weak points. The payback method suffers from two major problems. First, any decision rules about which projects to accept and

reject must be arbitrary. Obviously, most organizations using the payback technique have chosen some acceptable period, such as 3 or 4 years, and reject all projects that have payback longer than that period. The second problem is that it ignores cash flows that occur beyond the payback period. A project with a large expense in a later year, such as maintenance charge for a machine, would be approved although it might not be approved if the analysis period was longer. In general, the payback method favors short-term projects over long-term ones, even if the financial benefits of a long-term project are far greater.

Although, there are three reasons to favor this method:

1) It provides information about how long it takes for a project to pay off. Many organizations use payback analysis because of this seemingly logical appeal.
2) An organization can determine how long it will take to recover its initial investment, which may be an important consideration if cash flow is a problem.
3) It can be a fairly accurate representation of true results in situations where benefits are constant or increase over a long period of time.

Payback analysis should not be used to make financial decisions, but can be used to provide supplemental information.

5. Sensitivity Analysis

Sensitivity analysis is the simplest and most frequently used method for analyzing uncertainly. In essence, sensitivity analysis measures how the result is affected by change of the factors.(19, 29) There are two basic approaches to sensitivity analysis:

1) The variable-by-variable approach, which treats each variable separately.
2) The scenario approach, which treats variables in groups.

6. Productivity Index (33)

The Thailand Productivity Institute has performed the productivity index, which can be used to evaluate the potentiality of the manufacturing sector. The manufacturers can use this index as a comparing way to develop their manufactories. For public sector, this index can be used as the beneficial information to assign the policy and to measure the performance in their organizations. There are 49 items, which are divided into three parts that are cost management ratios, financial management ratios, and performance ratios.

The cost management ratios will be displayed in each production cost ratio. It can be used as guideline to adjust or to control unreasonable production costs. However, these cost reductions do not impact to the quality of products. For the financial management ratios, they can be used to evaluate the financial status, the efficiency and the ability on generating profit. The last index is the performance ratios or productivity ratios. In this study, some productivity indexes are selected based on availability of data. There are 15 items as the followings:

1) Cost management ratios

- % of Material cost = (Direct material cost / Total cost) * 100

Material cost is important variable cost in production process. If this index is higher than its industrial average, it means that material cost of manufacture is high which may be occurred from using low quality raw material.

- % of Production labor cost = (Direct labor cost / Total cost) * 100

This index focuses on direct labor cost in manufacturer unit. It can be used as the indicator on labor cost competition when compared with its industrial average. It should be considered along with the amount of processing per employee.

- % of Depreciation cost = (Depreciation / Total cost) * 100

This index should be considered along with the efficiency of machinery investment. If the investment of machines is high while they are not used at full capacity, production cost will be increased.

- % of Utility & energy cost = (Utility & energy cost / Total cost) * 100

This index focuses on utility and energy cost such as electricity, tap water, gasoline etc. If the index is higher than its industrial average, it means that the utility and energy are wasting used.

2) Financial management ratios

- Operating profit to sales ratio = Operating profit / sales

Operating profit is resulted from total sales subtracted by total costs. The index can be used as indicator to evaluate the ability on generating profit. If this index is higher than its industrial average, it means that the manufacture has the efficiency on cost management.

- Gross profit to sales ratio = Gross profit / sales

Gross profit is resulted from total sales subtracted by direct costs. The index is another indicator to evaluate the ability on generating profit. If this index is higher than its industrial average, it means that the manufacture has the efficiency on production cost control.

- Inventory turnover = Sales / Inventory

The inventory consists of raw materials, goods in process, and finished goods. This index is used to measure the efficiency on inventory management. If the index is lower than its industrial average, it means that the manufacture has over inventory that reflects to sunk cost.

- Raw materials turnover = Sales / Raw materials

Raw materials turnover is used to measure the efficiency on raw materials management. If the index is lower than its industrial average, it means that raw materials are over stock. It should be considered along with the product turnover.

- Goods in process turnover = Sales / Goods in process

This index is used to measure the efficiency on the management of goods in process. If the index is lower than its industrial average, it means that the manufacture has over goods in process, which may be affected from inappropriate production plan.

- Product turnover = Sales / Finished goods

Product turnover is used to measure the efficiency on finished goods management. If the index is lower than its industrial average, it means that finished goods are over stock, which are affected from the inability on sales.

3) Performance ratios

- Amount of production per employee = Sales / Number of employees

This index is used to measure the efficiency of each employee. If the index is lower than its industrial average, it means that the employees are low efficiency.

$$\text{- Amount of processing per employee} = \frac{\text{Amount of processing}}{\text{Number of employees}}$$

Amount of processing is resulted from total sales subtracted by material costs. If amount of processing per employee is higher than its industrial average, it means that the employees are high efficiency. It should be considered along with the amount of production per employee.

$$\text{- Efficiency of machinery investment ratio} = \frac{\text{Amount of processing}}{\text{Machinery and equipment}}$$

This index is used to measure the suitability of machinery investment. If it is lower than its industrial average, it means that the machines used are low performance, which may be affected from over machinery investment.

$$\text{- Material cost to production value ratio} = \frac{\text{Material cost}}{\text{Production value}}$$

This index should be considered along with the raw materials turnover or the material cost ratio. If material cost to production value ratio is higher than its industrial average, it means that material cost of manufacture is high which may be occurred from the used of low quality raw material.

$$\text{- Labor cost to production value ratio} = \frac{\text{Production labor cost}}{\text{Production value}}$$

This index is used to indicate the concentration of labor cost in production process. It should be considered along with the amount of processing per employee.

The productivity index has been reported since 2000. The data were collected from 2,000 manufacturers, which cover 13 industry branches. The data are being collected continuously in order to provide the beneficial information for both public and private users.

7. The Related Study in Thailand

There is only one study focused on herbal drug production cost that is cost analysis of herbal products at ChaoPhya Abhaibhubejhr Hospital.(12) The standard method was used to determine unit cost of herbal products. It included direct and indirect costs. The unit costs were composed of production and quality control costs. The results showed that unit costs of 36 herbal products ranged from 10.12 to 109.05 baht. From analyses of charge to cost ratio, it was found that more than 50 percent of herbal products items manufactured were not profitable because costs were more than their prices. In cost recovery analysis on dimension of accrual revenue and full cost, if the government did not subsidize some costs, the program could not make profits to the hospital.

Moreover, this study did not use micro-costing in unit cost calculation to determine herbal production cost and modern drug production cost, and did not focus on payback period and productivity of herbal production.

CHAPTER 3
METHODOLOGY

Study Design

This study was designed as a cross-sectional descriptive research. The data of U-thong Hospital in the fiscal year 2003 was used in all parts of the study.

Assumptions

1. Number of deflects during production process and stock were zero.
2. All products produced in the study period were all sold within the study period.
3. Loss or profit of herbal production in the past years were zero.
4. Product items, production process, and distribution rate of each product in the following years were stable.

Study Procedure

There were three parts in the study procedure:

1. Cost-benefit analysis
2. Payback period determination
3. Productivity evaluation

Part 1: Cost-benefit analysis

In this part, the processes were composed of cost determination, benefit determination, and cost-benefit analysis.

1. Cost determination

In this process, there were six minor steps: organization analysis of the hospital, direct costs determination, indirect costs determination, full costs calculation, unit cost calculation, and determination of herbal production cost.

1.1 Organization analysis of the hospital

Organizational structure of U-thong Hospital was analyzed to identify cost centers. All cost centers were categorized into TCCs and ACCs based on responsibility, resource consumption, and supporting relation. There were 43 cost centers, which consisted of 23 TCCs and 20 ACCs. All cost centers are shown in figure 3.

1.2 Direct costs determination

Direct costs were calculated from summation of capital costs, labor costs, and material costs of each cost center.

1.2.1 Capital costs

Capital costs were calculated from summation of depreciation costs of buildings and durable goods, and opportunity costs of land and stocked materials.

a) Depreciation costs of buildings and durable goods

In this study, depreciation costs of building and durable goods were calculated by using economic-based approach. According to the data from the Bank of Thailand, the inflation rate was very low, so the interest rate of a 12-month fixed deposit of the fiscal year 2003 was used as the discount rate that was 1.86 percent.(34, 35) Salvage value of buildings and durable goods were assumed to be zero. Estimated useful life of buildings were 20 years while those of durable goods were 5 years. The equation is below.

Equivalent annual cost = Current price/ Annuity factor

Current price = Original price X Inflation adjustment factor

Inflation adjustment factor

$$= \frac{\text{Price from Consumer Price Index table of the current year}}{\text{Price from Consumer Price Index table of the year of first using}}$$

Annuity factor = $[1 - (1+r)^{-n}]/r$

n = working year

r = discount rate

For the building occupied by more than one cost center, depreciation costs were divided to those cost centers based on the proportion of operating area of each cost center.

b) Opportunity costs of land and stocked materials

In this study, opportunity cost of land was valued as the annual land rental. Due to the availability of the market price, the annual land rental was calculated as an interest earned from the land prices.(36) The land prices were based on the estimation of the Department of Lands. The interest rate of a 12-month fixed deposit of the fiscal year 2003 was obtained from the Bank of Thailand. After that, opportunity cost of land was distributed to cost centers based on the proportion of operating area of each cost center.

Annual opportunity cost of land of each cost center
= cost of land x interest rate
x the proportion of operating area of each cost center

For opportunity cost of stocked materials, This cost was the opportunity loss of average cost of inventory kept during the studied year. It was assumed to be equal to amount of interest of the value of stocked materials. The interest rate of a 12-month fixed deposit in the fiscal year 2003 was used to perform the calculation.

Annual opportunity cost of stocked materials
= cost of stocked materials x interest rate

1.2.2 Labor costs

Labor costs of each cost center were calculated from summation of salary, wage, overtime (OT), training expense, and fringe benefits. For a person who working for more than one cost centers, labor costs in part of salary, wage, overtime (OT), and training expense were distributed to those cost centers, based on a proportion of working time that person spent for such cost centers. In case of fringe benefits and

salary of persons who are not work in the hospital, these costs were distributed to each cost center, based on a proportion of Full Time Equivalent (FTE) in each cost center. Full Time Equivalent (FTE) came form the summation of working time of each person in each cost center. Exceptionally, overtime (OT) of pharmacists in production unit was excluded and then included to pharmacy dispensing unit because this cost belonged to pharmacy dispensing unit only.

1.2.3 Material costs

Cost of materials consumed by each cost enter were determined, All materials were separated into two groups: materials collected according to the actual consumption of cost centers and shared materials unable to be collected the actual consumption of cost centers. In case of shared materials, these costs were distributed to all related cost centers by using suitable criteria. Table 2 shows material cost determination.

1.3 Indirect cost determination

Direct costs of transient cost centers, which directly support to absorbing cost centers, were allocated to absorbing cost centers by using simultaneous equation method and suitable criteria. The allocation criteria are shown in table2.

1.4 Full costs calculation

Full costs of absorbing cost centers were calculated from the summation of direct costs and indirect costs of each cost center. In this step, full cost of production unit was computed.

Figure 3 Cost center identification and classification of U-thong Hospital

Table 1: Material cost determination for each cost center

Material cost	Cost determination method
Discrete material	
Tap water	For tap water unit only
Telephone	Cost of telephone used by each cost center
Mail	Cost of mail used by each cost center
Internal photocopy	Cost of internal photocopy of each cost center
External photocopy	Cost of external photocopy of each cost center
Maintenance	Cost of materials used by each cost center
External services	Cost of external services of each cost center
Guard	For administration only
Fuel & car maintenance	For transportation only
General material	Cost of materials used by each cost center
Cloth	Cost of cloths used by each cost center
Dental material	For dental only
Drug & medical supply	Cost of materials used by each cost center
Foodstuff	For nutrition only
Shared material	
Electricity	Allocated by number of electrical appliance watts of each cost center
Digital photocopy	Allocated by number of photocopies of each cost center
Fuel & car maintenance *	Allocated by number of days used by 3 cost centers
Oxygen	Allocated by consumption estimation

* There is one which served for three cost centers, and a speed indicator could not be used.

Table 2: Allocation criteria of transient cost centers

Cost center ID	Transient cost center	Allocation criteria
T01	Administration	Number of FTE in each cost center
T02	Tap water unit	No. of FTE: No. of outpatient visits: No. of inpatient days (365:1:2)
T03	Garbage elimination unit	Weight of garbage
T04	Sewage disposal	No. of FTE: No. of outpatient visits: No. of inpatient days (365:1:2)
T05	Maintenance	Number of jobs requested by each cost center
T06	Gardening	Operating area
T07	purchasing	Cost of materials dispensed to each cost center
T08	Finance 1	Number of FTE in each cost center
T09	Finance 2	Number of services
T10	Planning unit	Number of FTE in each cost center
T11	Transportation	Distance (km) of transportation
T12	Information center	Number of documents dispensed to each cost center
T13	Medical center	No. of operated patients: No. of outpatient visits: No. of inpatient days (10:1:1)
T14	Nurse administration	Number of nursing personnel in each cost center
T15	Health education	Number of services
T16	Medical record	Number of services
T17	Stretcher unit	Number of services
T18	Corpse room	Number of services
T19	Central supply	Number of medical sets supplied to each cost center
T20	Sewing	Cost of clothes sewed to each cost center
T21	Laundry	Weight of dry clothes
T22	Nutrition	Number of food trays
T23	Drug and non-drug stock	Cost of drugs and non-drugs dispensed to each cost center

FTE = Full Time Equivalent

1.5 Unit cost calculation

Due to the various products that including modern and herbal drug were produced in the production unit. Therefore, micro-costing was used for unit cost calculation as the following steps:

First, direct production cost of each product was determined from directly consumed capital costs, labor costs, and material costs.

Second, indirect production cost of production unit was determined from the results of subtraction of full cost of production unit by total direct production costs of all products.

Third, indirect production cost of production unit was allocated to each product according to the proportion of direct cost of each product. Finally, unit cost of each product was summation of direct production cost and indirect production cost of each product.

1.6 Determination of herbal production cost

In this step, production cost of herbal products was determined by summation of multiplying of production quantity of each product by its unit cost.

2. Benefit determination

Benefit in this study referred to the revenue produced by the program. The revenue was calculated based on assumption that all of herbal products produced in the fiscal year 2003 were all sold in that year. So, benefit of herbal product production was determined by summation of multiplying of production quantity of each product by its wholesale price.

3. Cost-benefit analysis

After cost and benefit were determined, the analysis of cost and benefit was presented by two methods as the followings:

Net Benefit (NB) = Benefits – Costs

Benefit to Cost Ratio (BCR) = Benefits / Costs

Part 2: Payback period determination

Due to it was the financial analysis, the herbal production cost in the first year was recalculated by excluding the opportunity costs of land and stocked materials and depreciation cost of buildings and durable goods, and then including the current asset values of building and durable goods. After that, cost and benefit of the following years were estimated for analyzing the time required for recovery the initial cost. There are three steps.

1. Revenue forecast

The number of services and revenue data of TTM center in the fiscal year 2003 were used for predicting revenue of herbal production in the following years by using simple regression analysis.(37, 38) The equation as below:

$$\text{Revenue} = f(\text{number of services})$$

The number of services was defined as the summation of number of TTM services and number of consumers directly buying herbal products at TTM center. For the number of patients receiving herbal products at the hospital's outpatient department, it was not included because the data were unavailable.

After the simple regression equation was obtained, it was used to calculate the revenue in the following years by using the estimated number of services as independent variable. The estimated number of services was calculated by using the average monthly change during the last six-month of number of services in the fiscal year 2003. At last, the forecasted revenue of each following year was estimated to the revenue of production unit by multiplying with the ratio of production unit revenue to TTM center revenue in the fiscal year 2003.

2. Cost estimation of the following years

This estimation was based on a simple relationship between production cost and revenue. The ratio of production cost to revenue of the first year was used to determine the production cost in the following years.(32, 37) The equation as below:

$$\text{Cost} = \text{Forecasted revenue X } \frac{\text{Production cost in the fiscal year 2003}}{\text{Revenue in the fiscal year 2003}}$$

3. Payback period analysis

After costs and revenues (benefits) in the following years were determined, The time required for total benefits exceeding total costs was analyzed. In calculating the payback period, the interest rate of a 12-month fixed deposit in the fiscal year 2003 was used as the discount rate, and assumed that it was stable throughout the following years. The discounted net benefits (benefits subtracted by costs) were summed until a positive result was obtained. The equation as below:

$$\sum_{t=0}^{p} \frac{Xt}{(1+r_t)^t} \geq 0$$

p = the time needed to reach this positive sum

Xt = net benefit in period t

r_t = the discount rate for period t

Part 3: Productivity evaluation

Similarly to payback period determination, the herbal production cost was recalculated by excluding the opportunity costs of land and stocked materials. For the depreciation costs of buildings and durable goods, they were still included, but the calculation method was changed to accounting based approach. Based on available data , the productivity of herbal production in this study was determined by using selected formulas from productivity index of the Thailand Productivity Institute. The selected formulas were used in the study as below:

1. Cost management ratios

% of Material cost = (Direct material cost / Total cost) * 100

% of Production labor cost = (Direct labor cost / Total cost) * 100

% of Depreciation cost = (Depreciation / Total cost) * 100

% of Utility & energy cost = (Utility & energy cost / Total cost) * 100

Definitions:

Total cost referred to total herbal production cost.

Direct material cost referred to the material costs of raw materials and packaging materials used in herbal production.

Direct labor cost referred to the labor costs of pharmacists and assistants in herbal production.

Depreciation cost referred to the depreciation costs of building and durable goods in herbal production, which were calculated by using accounting based approach.

Utility & energy cost referred to the costs of tap water and electricity used in herbal production.

2. Financial management ratios

Operating profit to sales ratio	= Operating profit / Sales
Gross profit to sales ratio	= Gross profit / Sales
Inventory turnover	= Sales / Inventory
Raw materials turnover	= Sales / Raw materials
Goods in process turnover	= Sales / Goods in process
Product turnover	= Sales / Finished goods

Definitions:

Sales referred to the revenues produced by herbal production.

Operating profit referred to the result of sales subtracted by total cost.

Gross profit referred to the result of sales subtracted by direct herbal production cost (excluded indirect costs from TCCs).

Inventory referred to the costs of raw materials, goods in process, and finished goods, which accounted at the end of a fiscal year 2003.

Raw materials referred to the costs of raw materials stocked for herbal production at the end of a fiscal year 2003.

Goods in process referred to the costs of materials, labors, and capitals used in the process of production. They were calculated by multiplying the number of batches in the process of production with an average of direct herbal production per batch.

Finished goods referred to the costs of the remained herbal products at the end of a fiscal year 2003. They were the summation of multiplying the quantity of each remained product by its unit cost.

3. Performance ratios

Amount of production per employee = Sales / Number of employees

$$\text{Amount of processing per employee} = \frac{\text{Amount of processing}}{\text{Number of employees}}$$

$$\text{Efficiency of machinery investment ratio} = \frac{\text{Amount of processing}}{\text{Machinery and equipment}}$$

$$\text{Material cost to production value ratio} = \frac{\text{Material cost}}{\text{Production value}}$$

$$\text{Labor cost to production value ratio} = \frac{\text{Production labor cost}}{\text{Production value}}$$

Definitions:

Number of employees referred to the Full Time Equivalent.

Amount of processing referred to the result of sales subtracted by material cost of herbal production (included raw materials, packaging materials, and other materials).

Machinery and equipment referred to the value of machinery and equipment at the end of a fiscal year 2003. It was calculated by subtracting the current price of durable good with the accumulated depreciation cost.

Material cost referred to direct material cost.

Production labor cost referred to direct labor cost.

Production value referred to the direct herbal production cost (excluded indirect costs from TCCs).

Data Collection

The details of data collection are shown in the table 3.

Table 3: The data collection

Data item	Source of information
• Capital costs	
- Land and all constructions	- The construction file at planning unit
- Durable goods	- The durable goods file at planning unit
- Monetary value of stocked materials	- The stocked material reports of each department
- Operating area	- Measuring by hospital officers
• Material costs	
- Monetary value of drugs and medical materials	- The report of drug stock at planning unit
- Monetary value of office materials, maintenance, and other materials	- The report of purchasing department at planning unit
- Monetary value of utilities	- The report of accounting department at planning unit
• Labor costs	
- Labor expense data	- The reports of accounting department at planning unit
- Proportion of working time	- Self-reported of each cost center at planning unit
• Outputs of each cost center	- The report of each cost center at planning unit
• Production quantity of herbal products	- Recording from stocked cards at production unit
• Wholesale price of herbal products	- Price list of the production unit.
• Resource consumption of each product	
- Material cost	
> Amount of material used	- Working formula of each product at the production unit
> Material price (the price at the end of a fiscal year 2003)	- Stocked cards at drug stock
- Labor cost	
> Time spent of pharmacists and assistants (per unit)	- Estimated by production unit officers
- Depreciation cost	
> Time spent of each equipment (per unit)	- Estimated by production unit officers

Data Analysis

The assessment of data analysis was a descriptive statistic. The analyses were conducted by using Microsoft Excel.

1. Unit cost analysis

Cost per unit of each herbal product was determined.

2. Analysis of proportion of cost composition

Costs of product were analyzed to determine the proportion of their composition.

3. Cost-benefit analysis

Cost and benefit of herbal production were analyzed as net benefit and benefit to cost ratio.

4. Payback period analysis

The time required for total benefits exceed total costs was determined. In calculating the payback period, the discounted net benefits (benefits subtracted by costs) were summed until a positive result was obtained.

5. Sensitivity analysis

One-way sensitivity analysis was conducted for analyzing the uncertainty of the factors.

5.1 In cost benefit analysis, the calculation was repeated when the discount rate was varied to 0% and 3%, and the material prices were varied to ± 10%.

5.2 In payback period analysis, the calculation was repeated when using replacement prices as asset values. Replacement prices were calculated by adjusting original prices with Thai consumer price index. This was assumed to a situation of analysis at the start of investment. In addition, the estimated number of services was simulated to be ±10%.

6. Productivity evaluation

Productivity of herbal production in this study was determined by using selected formulas from productivity index, based on available data on cost and benefit. Then the studied ratios were compared with the reported ratios of the Thailand Productivity Institute.

CHAPTER 4
RESULTS

The results of this study were presented in three parts: 1) cost-benefit analysis; 2) payback period determination; and 3) productivity evaluation.

1. Cost-Benefit Analysis

1.1 Products and production volumes

The production unit was responsible for producing two product categories, which were herbal products and modern drugs. In the fiscal year 2003, total batches of all categories were 1,008. Herbal products accounted for 533 batches (52.88%) whereas modern drugs accounted for 475 batches (47.12%).

In herbal production, there were 76 product items produced in the fiscal year 2003. The production volumes are shown in table 4. The first three rankings of total production volumes were Cinnamomum Stomachic (180 ml./bottle), Safflower in Sachet (30 sachets/box), and Herbal Compress, respectively.

1.2 Direct, indirect, and full costs of production unit

The results showed that material costs were 1,983,985.18 baht (63.88%), labor costs were 953,385.16 baht (30.69%), and capital costs were 168,537.20 baht (5.43%). After summation, direct costs of production unit were 3,105,907.54 baht.

Direct costs, indirect costs, and full costs are presented in table 5. Full costs of production unit were 3,442,807.50 baht, which consisted of direct costs by 3,105,907.54 baht or 90.21% and indirect cost by 336,899.95 baht or 9.79%. When compared with total costs of U-thong Hospital, the full costs of production unit were 4.48% of all. In absorbing cost center group, the production unit consumed costs expensively as the tenth rank.

Table 4: Herbal products produced in the fiscal year 2003

No.	Product's name		Herb	Production		
	Thai name	English name	Botanical name	Unit	Total batches	Quantity
1	ขมิ้นชันแคปซูล	Tumeric capsule	*Curcuma longa*	Bottle (1000 caps.)	3	11
				Bottle (100 caps.)	21	2,109
2	ขี้เหล็กแคปซูล	Khee Lek capsule	*Cassia siamea*	Bottle (100 caps.)	5	630
3	บอระเพ็ดแคปซูล	Borapet capsule	*Tinospora crispa*	Bottle (100 caps.)	7	719
4	เพชรสังฆาตแคปซูล	Petsangkhaat capsule	*Cissus quadrangularis*	Bottle (100 caps.)	11	1,484
5	ฟ้าทะลายโจรแคปซูล	Fa Ta Lai capsule	*Andrographis paniculata*	Bottle (1000 caps.)	1	3
				Bottle (100 caps.)	11	1,912
6	ลูกใต้ใบแคปซูล	Luuk Tai Bai capsule	*Phyllantus amarus*	Bottle (100 caps.)	2	452
7	ลดการอยากอาหารแคปซูล *	Appetite Reducing capsule	-	Bottle (1000 caps.)	3	12
				Bottle (100 caps.)	18	2,326
8	สหัสธาราแคปซูล *	Sahat Thara capsule	-	Bottle (1000 caps.)	1	7
				Bottle (100 caps.)	12	1,962
8	เหงือกปลาหมอ-พริกไทยแคปซูล	Sea Holly & Pepper capsule	*Acanthus ebracteatus* *Piper nigrum*	Bottle (100 caps.)	6	1,040
10	เห็ดหลินจือแคปซูล	Lin-Zhi capsule	*Ganoderma lucidum*	Bottle (1000 caps.)	1	3
				Bottle (100 caps.)	11	1,944
11	อายุวัฒนะแคปซูล *	Increase Longevity capsule	-	Bottle (1000 caps.)	4	32
				Bottle (100 caps.)	10	1,530
12	ลูกยอแคปซูล	Indian Mulberry capsule	*Morinda citrifolia*	Bottle (100 caps.)	8	794
13	หญ้าปักกิ่งแคปซูล	Leng Ju Chao capsule	*Murdannia loriformis*	Bottle (100 caps.)	10	1,078
14	กระชายดำแคปซูล	Krachai Dum capsule	*Keampferia parviflora*	Bottle (100 caps.)	3	296

Table 4: Herbal products produced in the fiscal year 2003 (continued)

No.	Product's name		Herb	Production		
	Thai name	English name	Botanical name	Unit	Total batches	Quantity
15	บัวบกแคปซูล	Asiatic Pennywort capsule	*Centella asiatica*	Bottle (100 caps.)	2	530
16	ว่านชักมดลูกแคปซูล	Wan Chuck Mod Luuk capsule	*Curcuma xanthorrhiza*	Bottle (1000 caps.)	1	9
				Bottle (100 caps.)	15	2,238
17	มะระแคปซูล	Balsam Pear capsule	*Momordica charantia*	Bottle (1000 caps.)	2	6
				Bottle (100 caps.)	6	537
18	ส้มแขกแคปซูล	Garcinia capsule	*Garcinia atroviridis*	Bottle (1000 caps.)	1	3
				Bottle (100 caps.)	14	1,594
19	ยาเม็ดธรณีสัณฑฆาต *	Throranee Santhakaat pill	-	Bottle (200 tabs.)	6	409
20	ยาเม็ดริดสีดวงทวาร *	Hemorrhoid pill	-	Bottle (1000 tabs.)	2	8
				Bottle (200 tabs.)	8	509
21	ยาเม็ดประสระไพร *	Pra Sa Pai pill	-	Bottle (200 tabs.)	6	453
22	ยาอมรสมะนาว	Lime lozenge	*Citrus aurantifolia*	Bottle (100 tabs.)	4	1,435
23	ยาอมรสบ๊วย	Prunus lozenge	*Prunus mume*	Bottle (100 tabs.)	7	2,215
24	ยาอมรสกานพลู	Clove lozenge	*Syzygium aromaticum*	Bottle (100 tabs.)	5	2,168
25	ชาหญ้าดอกขาว	Vernonia in sachet	*Vernonia cinerea*	Box (30 sachets)	13	1,852
				Pack (10 sachets)	1	200
26	ชาคำฝอย	Safflower in sachet	*Carthamus tinctorius*	Box (30 sachets)	43	4,596
				Pack (10 sachets)	6	706
27	ชารางจืด	Rang Jurd in sachet	*Thunbergia laurifolia*	Box (30 sachets)	15	857
				Pack (10 sachets)	5	338

Table 4: Herbal products produced in the fiscal year 2003 (continued)

No.	Product's name		Herb	Production		
	Thai name	English name	Botanical name	Unit	Total batches	Quantity
28	ชากระเจี๊ยบ	Roselle in sachet	*Hibiscus sabdariffa*	Box (30 sachets)	6	425
				Pack (10 sachets)	5	321
29	ชาหญ้าหนวดแมว	Cat's Whisker in sachet	*Orthosiphon aristatus*	Box (30 sachets)	12	814
				Pack (10 sachets)	5	421
30	ชามะขามแขก	Senna in sachet	*Cassia angustifolia*	Box (30 sachets)	21	1,949
				Pack (10 sachets)	3	336
31	ชาชะพลู	Chaa Phluu in sachet	*Piper sarmentosum*	Pack (10 sachets)	2	343
32	ชาตะไคร้	Lemon Glass in sachet	*Cymbopogon citratus*	Pack (10 sachets)	4	468
33	ชาขิง	Ginger in sachet	*Zingiber officinale*	Pack (10 sachets)	3	345
34	ยาธาตุอบเชย	Cinnamomum Stomachic	*Cinnamomum sp.*	Bottle (180 ml.)	18	6,522
35	ยาหอมนวโกฐ *	Ya Hom Nawagaoth	-	Bottle (30 g.)	9	928
36	ทองพันชั่งทิงเจอร์	Tong Pun Chung tincture	*Rhinacanthus nasutus*	Bottle (30 ml.)	7	994
37	เสลดพังพอนทิงเจอร์	Paya Yor tincture	*Clinacanthus nutans*	Bottle (30 ml.)	6	836
38	เสลดพังพอนกลีเซอรีน	Paya Yor glycerine	*Clinacanthus nutans*	Bottle (5 ml.)	5	813
39	สเปรย์ตะไคร้หอม	Mosquito repellent	*Citronella grass*	Spray (60 ml.)	3	95
40	ยาหม่องเสลดพังพอน	Paya Yor balm	*Clinacanthus nutans*	Bottle (10 g.)	6	459
41	คาลาไมด์เสลดพังพอน	Paya Yor calamine	*Clinacanthus nutans*	Bottle (60 ml.)	7	564
42	ยาอมบ้วนปากใบฝรั่ง	Guava mouth wash	*Psidium guajava*	Bottle (200 ml.)	14	592
43	สเปรย์ใบฝรั่ง	Mouth deodorant spray	*Psidium guajava*	Spray (60 ml.)	1	58

Table 4: Herbal products produced in the fiscal year 2003 (continued)

No.	Product's name		Herb	Production		
	Thai name	English name	Botanical name	Unit	Total batches	Quantity
44	ยาอบสมุนไพร *	Herbal Steam Bath	-	Pack (plastic bag)	9	491
				Pack (cloth bag)	8	299
45	ลูกประคบ *	Herbal Compress	-	Pack	33	2,357
46	แชมพูอัญชัน	Blu Pea shampoo	*Clitoria ternatea*	Bottle (250 ml.)	6	559
47	แชมพูว่านหางจรเข้-มะกรูด	Aloe & Leech Lime shampoo	*Aloe vera* *Citrus hystrix*	Bottle (250 ml.)	3	235
48	แชมพูใบพลู-มะกรูด	Betel & Leech Lime shampoo	*Piper betle* *Citrus hystrix*	Bottle (250 ml.)	2	79
49	แชมพูมะคำดีควาย	Soapberry shampoo	*Sapindus emarginatus*	Bottle (250 ml.)	4	309
50	แชมพูขิง	Ginger shampoo	*Zingiber officinale*	Bottle (250 ml.)	1	75
51	แชมพูบอระเพ็ด	Borapet shampoo	*Tinospora crispa*	Bottle (250 ml.)	2	146
52	ครีมนวดผมอัญชัน	Blu Pea hair conditioner	*Clitoria ternatea*	Bottle (250 ml.)	4	298
53	ครีมนวดผมว่านหางจรเข้-มะกรูด	Aloe & Leech Lime hair conditioner	*Aloe vera* *Citrus hystrix*	Bottle (250 ml.)	2	141
54	ครีมนวดผมใบพลู-มะกรูด	Betel & Leech Lime hair conditioner	*Piper betle* *Citrus hystrix*	Bottle (250 ml.)	2	66
55	ครีมนวดผมมะคำดีควาย	Soapberry hair conditioner	*Sapindus emarginatus*	Bottle (250 ml.)	2	130
56	ครีมนวดผมขิง	Ginger hair conditioner	*Zingiber officinale*	Bottle (250 ml.)	1	66
57	ครีมนวดผมบอระเพ็ด	Borapet hair conditioner	*Tinospora crispa*	Bottle (250 ml.)	2	117
58	สบู่เหลวมังคุด	Mangosteen liquid soap	*Garcinia mangostana*	Bottle (250 ml.)	3	84
59	สบู่เหลวขมิ้น	Tumeric liquid soap	*Curcuma longa*	Bottle (250 ml.)	2	81

* Mixed preparations

Table 5: Direct, indirect, and full costs of absorbing cost centers at U-thong Hospital in the fiscal year 2003

Cost center ID	Absorbing cost centers	Direct cost		Indirect cost		Full cost		
A01	Production unit	3,105,907.54	(90.21%)	336,899.95	(9.79%)	3,442,807.50	(100%)	{4.48%}
A02	Pharmacy dispensing	16,668,345.50	(95.49%)	787,212.28	(4.51%)	17,455,557.78	(100%)	{22.69%}
A03	Radiation	1,064,602.44	(83.21%)	214,864.29	(16.79%)	1,279,466.73	(100%)	{1.66%}
A04	Laboratory	3,778,509.93	(90.92%)	377,406.03	(9.08%)	4,155,915.96	(100%)	{5.40%}
A05	Operating room	2,774,265.09	(73.64%)	992,854.37	(26.36%)	3,767,119.46	(100%)	{4.90%}
A06	Counseling room	280,183.35	(73.05%)	103,388.93	(26.95%)	383,572.27	(100%)	{0.50%}
A07	Rehabilitation	93,655.33	(44.42%)	117,175.87	(55.58%)	210,831.20	(100%)	{0.27%}
A08	Dental	1,607,131.35	(74.85%)	540,065.84	(25.15%)	2,147,197.19	(100%)	{2.79%}
A09	Emergency	3,244,992.62	(54.77%)	2,679,903.07	(45.23%)	5,924,895.69	(100%)	{7.70%}
A10	Outpatient service	1,916,690.93	(31.30%)	4,207,374.22	(68.70%)	6,124,065.15	(100%)	{7.96%}
A11	Health center	594,220.49	(74.62%)	202,131.25	(25.38%)	796,351.74	(100%)	{1.04%}
A12	Day care service	147,465.31	(78.64%)	40,046.79	(21.36%)	187,512.09	(100%)	{0.24%}
A13	Thai traditional medicine	1,707,416.67	(80.71%)	407,950.39	(19.29%)	2,115,367.06	(100%)	{2.75%}
A14	PCU	199,426.24	(80.62%)	47,928.67	(19.38%)	247,354.91	(100%)	{0.32%}
A15	Inpatient ward	4,398,044.02	(56.07%)	3,445,329.00	(43.93%)	7,843,373.02	(100%)	{10.20%}
A16	ICU	4,395,983.99	(73.12%)	1,616,249.73	(26.88%)	6,012,233.72	(100%)	{7.82%}
A17	Obstetric ward	3,766,828.87	(71.65%)	1,490,629.46	(28.35%)	5,257,458.33	(100%)	{6.83%}
A18	VIP	3,641,755.25	(66.73%)	1,815,313.67	(33.27%)	5,457,068.93	(100%)	{7.09%}
A19	Sanitation	1,067,273.73	(82.03%)	233,764.81	(17.97%)	1,301,038.54	(100%)	{1.69%}
A20	Health promotion	1,841,472.84	(65.24%)	981,099.65	(34.76%)	2,822,572.49	(100%)	{3.67%}
	Total	**56,294,171.49**	**(73.17%)**	**20,637,588.26**	**(26.83%)**	**76,931,759.76**	**(100%)**	**{100%}**

1.3 Production costs of herbal products and modern drugs

Most of production costs of production unit were used for produced herbal products. The results showed that herbal production costs were 2,322,521.92 baht (67.46%) whereas modern drug production costs were 1,120,285.58 baht (32.54%). In case of quality control costs, these costs were included to only herbal production costs due to the quality control was not applied to modern drug production. The cost details are shown in table 6.

1.4 Unit cost of herbal products

Unit cost of a herbal product comprised of direct production cost per unit, quality control cost per unit, and indirect production cost per unit. The cost details are shown in table 7-8.

Direct production cost per unit of all herbal products were between 8.78 – 365.60 baht and accounted for 57.89% – 75.25% of total cost per unit of all products. Cost of material, labor, and capital accounted for 14.03% - 66.97%, 8.19% - 61.14%, and 0.05% - 4.50%, respectively.

Quality control cost per unit of all herbal products were between 0.03 – 35.92 baht and accounted for 0.26% – 17.36% of total cost per unit of all products. Cost of labor and capital accounted for 0.18% – 12.13% and 0.08% - 5.23% respectively. However, these costs were not included material cost due to the data were unavailable. Moreover, the quality control cost per unit of some herbal products was zero because the quality control was not applied to their products.

Briefly, unit cost of all herbal products were between 11.71 – 530.33 baht. Most of cost were direct production cost especially material cost. Each product had indirect production cost that was 24.75%.

1.5 Total production costs, revenues, and cost-benefit analysis

To analyze cost and benefit of herbal production, it needs to know revenue produced by the program in the fiscal year 2003. In this study, the revenue was calculated based on assumption that all of herbal products produced in the fiscal year

2003 were all sold in that year. Therefore, the total monetary value of all herbal products produced in the fiscal year 2003 was used as the revenue of the program. As a result, the revenue was calculated by summation of multiplying production volume with their wholesale prices.

It was found that the revenue of the program was 2,422,848.00 baht. When it was compared to the total costs 2,322,521.92 baht, the results indicated that the net benefit was 100,326.08 baht and the benefit to cost ratio was 1.04.

Considering by product items, in case of the net benefit, Appetite Reducing capsule (100 caps.) was highest net benefit, followed by Lin-Zhi capsule (100 caps.) and Krachai Dum capsule (100 caps.). In contrast, Herbal Compress was lowest net benefit. In case of benefit to cost ratio, Krachai Dum capsule (100 caps.) was highest ratio, followed by Appetite Reducing capsule (100 caps.) and Lin-Zhi capsule (100 caps.), while Guava mouth wash (200 ml.) and Mouth deodorant spray (60 ml.) were lowest ratio. The results are shown in table 9.

Table 6: Total production costs in the fiscal year 2003

Description	Direct production cost			Quality control cost		Indirect production cost	Total
	Material	Labor	Capital	Labor	Capital		
Herbal production	1,058,868.14	601,086.86	29,716.43	40,424.13	17,529.11	574,897.24	2,322,521.92
	(45.60%)	(25.88%)	(1.28%)	(1.74%)	(0.75%)	(24.75%)	(100.00%)
Modern drug production	529,274.02	311,874.17	1,831.46	-	-	277,305.93	1,120,285.58
	(47.25%)	(27.84%)	(0.16%)	(0.00%)	(0.00%)	(24.75%)	(100.00%)
Total	1,588,142.16	912,961.03	31,547.89	40,424.13	17,529.11	852,203.17	3,442,807.50
	(46.13%)	(26.52%)	(0.92%)	(1.17%)	(0.51%)	(24.75%)	(100.00%)

Table 7: Unit cost of herbal products in the fiscal year 2003; classified by production and quality control cost

Products	Unit	Direct production cost per unit		Quality control cost per unit		Indirect production cost per unit		Total cost per unit	
Tumeric capsule	Bottle (1000 caps.)	254.83	(67.90%)	27.57	(7.35%)	92.90	(24.75%)	375.30	(100%)
Fa Ta Lai capsule	Bottle (1000 caps.)	232.08	(65.54%)	34.39	(9.71%)	87.66	(24.75%)	354.13	(100%)
Appetite Reducing capsule	Bottle (1000 caps.)	227.91	(67.81%)	25.02	(7.44%)	83.20	(24.75%)	336.13	(100%)
Sahat Thara capsule	Bottle (1000 caps.)	274.49	(71.52%)	14.30	(3.73%)	95.00	(24.75%)	383.78	(100%)
Lin-Zhi capsule	Bottle (1000 caps.)	365.60	(68.94%)	33.46	(6.31%)	131.27	(24.75%)	530.33	(100%)
Increase Longevity capsule	Bottle (1000 caps.)	219.38	(71.19%)	12.51	(4.06%)	76.28	(24.75%)	308.17	(100%)
Wan Chuck Mod Luuk capsule	Bottle (1000 caps.)	295.35	(72.35%)	11.83	(2.90%)	101.05	(24.75%)	408.22	(100%)
Balsam Pear capsule	Bottle (1000 caps.)	252.32	(65.87%)	35.92	(9.38%)	94.82	(24.75%)	383.05	(100%)
Garcinia capsule	Bottle (1000 caps.)	362.08	(68.88%)	33.48	(6.37%)	130.12	(24.75%)	525.68	(100%)
Tumeric capsule	Bottle (100 caps.)	37.72	(72.78%)	1.28	(2.47%)	12.83	(24.75%)	51.83	(100%)
Khee lek capsule	Bottle (100 caps.)	33.72	(72.85%)	1.11	(2.40%)	11.46	(24.75%)	46.29	(100%)
Borapet capsule	Bottle (100 caps.)	34.13	(69.94%)	2.59	(5.31%)	12.08	(24.75%)	48.79	(100%)
Petsangkhaat capsule	Bottle (100 caps.)	36.05	(72.94%)	1.14	(2.31%)	12.23	(24.75%)	49.43	(100%)
Fa Ta Lai capsule	Bottle (100 caps.)	35.45	(71.97%)	1.61	(3.28%)	12.19	(24.75%)	49.25	(100%)
Luuk Tai Bai capsule	Bottle (100 caps.)	33.09	(71.45%)	1.76	(3.80%)	11.46	(24.75%)	46.32	(100%)
Appetite Reducing capsule	Bottle (100 caps.)	34.49	(73.60%)	0.77	(1.65%)	11.60	(24.75%)	46.87	(100%)
Sahat Thara capsule	Bottle (100 caps.)	39.69	(74.11%)	0.61	(1.14%)	13.26	(24.75%)	53.56	(100%)
Sea Holly & Pepper capsule	Bottle (100 caps.)	37.61	(72.30%)	1.53	(2.95%)	12.88	(24.75%)	52.02	(100%)
Lin-Zhi capsule	Bottle (100 caps.)	48.80	(74.23%)	0.67	(1.02%)	16.27	(24.75%)	65.74	(100%)
Increase Longevity capsule	Bottle (100 caps.)	34.18	(73.84%)	0.65	(1.41%)	11.46	(24.75%)	46.29	(100%)
Indian Mulberry capsule	Bottle (100 caps.)	33.49	(68.58%)	3.26	(6.67%)	12.09	(24.75%)	48.84	(100%)
Leng Ju Chao capsule	Bottle (100 caps.)	41.03	(70.49%)	2.77	(4.76%)	14.41	(24.75%)	58.21	(100%)
Krachai Dum capsule	Bottle (100 caps.)	69.10	(73.46%)	1.68	(1.79%)	23.29	(24.75%)	94.07	(100%)
Asiatic Pennywort capsule	Bottle (100 caps.)	42.38	(71.45%)	2.25	(3.80%)	14.68	(24.75%)	59.31	(100%)
Garcinia capsule	Bottle (100 caps.)	48.45	(73.72%)	1.00	(1.53%)	16.27	(24.75%)	65.72	(100%)
Wan Chuck Mod Luuk capsule	Bottle (100 caps.)	41.77	(72.85%)	1.38	(2.40%)	14.19	(24.75%)	57.34	(100%)
Balsam Pear capsule	Bottle (100 caps.)	37.47	(68.53%)	3.68	(6.72%)	13.54	(24.75%)	54.68	(100%)

Table 7: Unit cost of herbal products in the fiscal year 2003; classified by production and quality control cost (continued)

Products	Unit	Direct production cost per unit		Quality control cost per unit		Indirect production cost per unit		Total cost per unit	
Hemorrhoid pill	Bottle (1000 tabs.)	141.60	(63.95%)	25.02	(11.30%)	54.81	(24.75%)	221.43	(100%)
Throranee Santhakaat pill	Bottle (200 tabs.)	30.60	(71.81%)	1.47	(3.44%)	10.55	(24.75%)	42.62	(100%)
Hemorrhoid pill	Bottle (200 tabs.)	33.88	(71.91%)	1.57	(3.34%)	11.66	(24.75%)	47.12	(100%)
Pra Sa Pai pill	Bottle (200 tabs.)	25.11	(71.48%)	1.33	(3.77%)	8.70	(24.75%)	35.13	(100%)
Lime lozenge	Bottle (100 tabs.)	9.25	(75.25%)	-	(0.00%)	3.04	(24.75%)	12.29	(100%)
Prunus lozenge	Bottle (100 tabs.)	10.22	(75.25%)	-	(0.00%)	3.36	(24.75%)	13.59	(100%)
Clove lozenge	Bottle (100 tabs.)	11.87	(75.25%)	-	(0.00%)	3.91	(24.75%)	15.78	(100%)
Vernonia in sachet	Box (30 sachets)	20.63	(72.12%)	0.90	(3.13%)	7.08	(24.75%)	28.61	(100%)
Safflower in sachet	Box (30 sachets)	31.27	(72.89%)	1.01	(2.36%)	10.62	(24.75%)	42.90	(100%)
Rang Jurd in sachet	Box (30 sachets)	24.46	(68.49%)	2.42	(6.76%)	8.84	(24.75%)	35.72	(100%)
Roselle in sachet	Box (30 sachets)	27.01	(65.95%)	3.81	(9.30%)	10.14	(24.75%)	40.96	(100%)
Cat's Whisker in sachet	Box (30 sachets)	24.22	(67.96%)	2.60	(7.29%)	8.82	(24.75%)	35.65	(100%)
Senna in sachet	Box (30 sachets)	22.95	(71.61%)	1.17	(3.64%)	7.93	(24.75%)	32.05	(100%)
Vernonia in sachet	Pack (10 sachets)	10.40	(70.54%)	0.69	(4.71%)	3.65	(24.75%)	14.75	(100%)
Safflower in sachet	Pack (10 sachets)	14.60	(70.77%)	0.93	(4.48%)	5.11	(24.75%)	20.63	(100%)
Rang Jurd in sachet	Pack (10 sachets)	12.33	(64.10%)	2.14	(11.15%)	4.76	(24.75%)	19.24	(100%)
Roselle in sachet	Pack (10 sachets)	13.18	(57.89%)	3.95	(17.36%)	5.64	(24.75%)	22.77	(100%)
Cat's Whisker in sachet	Pack (10 sachets)	12.55	(63.54%)	2.31	(11.71%)	4.89	(24.75%)	19.75	(100%)
Senna in sachet	Pack (10 sachets)	11.83	(69.49%)	0.98	(5.76%)	4.21	(24.75%)	17.02	(100%)
Chaa Phluu in sachet	Pack (10 sachets)	11.88	(68.54%)	1.16	(6.71%)	4.29	(24.75%)	17.33	(100%)
Lemon Glass in sachet	Pack (10 sachets)	13.75	(60.33%)	3.40	(14.92%)	5.64	(24.75%)	22.79	(100%)
Ginger in sachet	Pack (10 sachets)	13.18	(68.59%)	1.28	(6.66%)	4.76	(24.75%)	19.22	(100%)
Cinnamomum Stomachic	Bottle (180 ml.)	8.78	(74.99%)	0.03	(0.26%)	2.90	(24.75%)	11.71	(100%)
Ya Hom Nawagaoth	Bottle (30 g.)	16.45	(75.25%)	-	(0.00%)	5.41	(24.75%)	21.87	(100%)
Tong Pun Chung tincture	Bottle (30 ml.)	11.34	(71.47%)	0.60	(3.78%)	3.93	(24.75%)	15.86	(100%)
Paya Yor tincture	Bottle (30 ml.)	11.50	(74.77%)	0.07	(0.48%)	3.81	(24.75%)	15.39	(100%)
Paya Yor glycerine	Bottle (5 ml.)	15.41	(74.89%)	0.07	(0.36%)	5.09	(24.75%)	20.58	(100%)

Table 7: Unit cost of herbal products in the fiscal year 2003; classified by production and quality control cost (continued)

Products	Unit	Direct production cost per unit		Quality control cost per unit		Indirect production cost per unit		Total cost per unit	
Mosquito repellent	Spray (60 ml.)	26.75	(75.25%)	-	(0.00%)	8.80	(24.75%)	35.55	(100%)
Paya Yor balm	Bottle (10 g.)	16.10	(74.90%)	0.07	(0.35%)	5.32	(24.75%)	21.50	(100%)
Paya Yor calamine	Bottle (60 ml.)	10.29	(74.71%)	0.07	(0.54%)	3.41	(24.75%)	13.77	(100%)
Guava mouth wash	Bottle (200 ml.)	46.88	(75.25%)	-	(0.00%)	15.42	(24.75%)	62.31	(100%)
Mouth deodorant spray	Spray (60 ml.)	42.66	(75.25%)	-	(0.00%)	14.03	(24.75%)	56.70	(100%)
Herbal Steam Bath (plastic bag)	Pack	19.89	(75.25%)	-	(0.00%)	6.54	(24.75%)	26.44	(100%)
Herbal Steam Bath (cloth bag)	Pack	30.86	(75.25%)	-	(0.00%)	10.15	(24.75%)	41.01	(100%)
Herbal Compress	Pack	39.73	(75.25%)	-	(0.00%)	13.07	(24.75%)	52.80	(100%)
Blu Pea shampoo	Bottle (250 ml.)	35.50	(75.25%)	-	(0.00%)	11.68	(24.75%)	47.18	(100%)
Aloe & Leech Lime shampoo	Bottle (250 ml.)	29.72	(75.25%)	-	(0.00%)	9.78	(24.75%)	39.50	(100%)
Betel & Leech Lime shampoo	Bottle (250 ml.)	29.06	(75.25%)	-	(0.00%)	9.56	(24.75%)	38.62	(100%)
Soapberry shampoo	Bottle (250 ml.)	28.47	(75.25%)	-	(0.00%)	9.37	(24.75%)	37.84	(100%)
Ginger shampoo	Bottle (250 ml.)	28.84	(74.20%)	0.41	(1.05%)	9.62	(24.75%)	38.87	(100%)
Borapet shampoo	Bottle (250 ml.)	28.60	(71.22%)	1.62	(4.03%)	9.94	(24.75%)	40.15	(100%)
Blu Pea hair conditioner	Bottle (250 ml.)	17.96	(75.25%)	-	(0.00%)	5.91	(24.75%)	23.86	(100%)
Aloe & Leech Lime hair conditioner	Bottle (250 ml.)	17.46	(75.25%)	-	(0.00%)	5.74	(24.75%)	23.20	(100%)
Betel & Leech Lime hair conditioner	Bottle (250 ml.)	17.07	(75.25%)	-	(0.00%)	5.62	(24.75%)	22.69	(100%)
Soapberry hair conditioner	Bottle (250 ml.)	17.11	(75.25%)	-	(0.00%)	5.63	(24.75%)	22.74	(100%)
Ginger hair conditioner	Bottle (250 ml.)	18.23	(73.60%)	0.41	(1.65%)	6.13	(24.75%)	24.76	(100%)
Borapet hair conditioner	Bottle (250 ml.)	18.23	(69.12%)	1.62	(6.13%)	6.53	(24.75%)	26.37	(100%)
Mangosteen liquid soap	Bottle (250 ml.)	39.19	(75.25%)	-	(0.00%)	12.89	(24.75%)	52.08	(100%)
Tumeric liquid soap	Bottle (250 ml.)	39.19	(75.25%)	-	(0.00%)	12.89	(24.75%)	52.08	(100%)

Table 8: Unit cost of herbal products in the fiscal year 2003; classified by material, labor, and capital cost

Products	Unit	Direct production cost per unit						Quality control cost per unit				Indirect production cost per unit		Total cost per unit	
		Material		Labor		Capital		Labor		Capital					
Tumeric capsule	Bottle (1000 caps.)	172.50	(45.97%)	65.42	(17.43%)	16.90	(4.50%)	19.17	(5.11%)	8.40	(2.24%)	92.90	(24.75%)	375.30	(100%)
Fa Ta Lai capsule	Bottle (1000 caps.)	178.01	(50.27%)	48.14	(13.59%)	5.94	(1.68%)	23.92	(6.75%)	10.48	(2.96%)	87.66	(24.75%)	354.13	(100%)
Appetite Reducing capsule	Bottle (1000 caps.)	172.80	(51.41%)	48.86	(14.54%)	6.25	(1.86%)	17.39	(5.17%)	7.62	(2.27%)	83.20	(24.75%)	336.13	(100%)
Sahat Thara capsule	Bottle (1000 caps.)	219.38	(57.16%)	48.86	(12.73%)	6.25	(1.63%)	9.94	(2.59%)	4.36	(1.14%)	95.00	(24.75%)	383.78	(100%)
Lin-Zhi capsule	Bottle (1000 caps.)	315.67	(59.53%)	45.24	(8.53%)	4.69	(0.88%)	23.26	(4.39%)	10.20	(1.92%)	131.27	(24.75%)	530.33	(100%)
Increase Longevity capsule	Bottle (1000 caps.)	166.00	(53.87%)	47.65	(15.46%)	5.73	(1.86%)	8.70	(2.82%)	3.81	(1.24%)	76.28	(24.75%)	308.17	(100%)
Wan Chuck Mod Luuk capsule	Bottle (1000 caps.)	240.24	(58.85%)	48.86	(11.97%)	6.25	(1.53%)	8.23	(2.02%)	3.60	(0.88%)	101.05	(24.75%)	408.22	(100%)
Balsam Pear capsule	Bottle (1000 caps.)	198.94	(51.93%)	47.65	(12.44%)	5.73	(1.50%)	24.99	(6.53%)	10.93	(2.85%)	94.82	(24.75%)	383.05	(100%)
Garcinia capsule	Bottle (1000 caps.)	298.85	(56.85%)	51.76	(9.85%)	11.47	(2.18%)	23.28	(4.43%)	10.20	(1.94%)	130.12	(24.75%)	525.68	(100%)
Tumeric capsule	Bottle (100 caps.)	22.15	(42.74%)	13.83	(26.69%)	1.74	(3.35%)	0.89	(1.72%)	0.39	(0.75%)	12.83	(24.75%)	51.83	(100%)
Khee Lek capsule	Bottle (100 caps.)	20.88	(45.10%)	12.17	(26.30%)	0.67	(1.45%)	0.77	(1.67%)	0.34	(0.73%)	11.46	(24.75%)	46.29	(100%)
Borapet capsule	Bottle (100 caps.)	21.45	(43.97%)	12.05	(24.70%)	0.62	(1.27%)	1.81	(3.71%)	0.78	(1.60%)	12.08	(24.75%)	48.79	(100%)
Petsangkhaat capsule	Bottle (100 caps.)	23.20	(46.95%)	12.17	(24.63%)	0.67	(1.36%)	0.80	(1.61%)	0.35	(0.70%)	12.23	(24.75%)	49.43	(100%)
Fa Ta Lai capsule	Bottle (100 caps.)	22.71	(46.10%)	12.10	(24.57%)	0.64	(1.30%)	1.13	(2.29%)	0.49	(0.99%)	12.19	(24.75%)	49.25	(100%)
Luuk Tai Bai capsule	Bottle (100 caps.)	20.59	(44.47%)	11.93	(25.76%)	0.57	(1.22%)	1.23	(2.66%)	0.53	(1.14%)	11.46	(24.75%)	46.32	(100%)
Appetite Reducing capsule	Bottle (100 caps.)	21.65	(46.19%)	12.17	(25.98%)	0.67	(1.43%)	0.54	(1.15%)	0.24	(0.50%)	11.60	(24.75%)	46.87	(100%)
Sahat Thara capsule	Bottle (100 caps.)	26.84	(50.13%)	12.17	(22.73%)	0.67	(1.25%)	0.43	(0.79%)	0.19	(0.35%)	13.26	(24.75%)	53.56	(100%)
Sea Holly & Pepper capsule	Bottle (100 caps.)	25.11	(48.27%)	11.93	(22.94%)	0.57	(1.09%)	1.07	(2.06%)	0.46	(0.89%)	12.88	(24.75%)	52.02	(100%)
Lin-Zhi capsule	Bottle (100 caps.)	36.47	(55.48%)	11.81	(17.97%)	0.51	(0.78%)	0.47	(0.71%)	0.20	(0.31%)	16.27	(24.75%)	65.74	(100%)
Increase Longevity capsule	Bottle (100 caps.)	21.50	(46.46%)	12.05	(26.04%)	0.62	(1.34%)	0.45	(0.98%)	0.20	(0.43%)	11.46	(24.75%)	46.29	(100%)
Indian Mulberry capsule	Bottle (100 caps.)	20.67	(42.33%)	12.16	(24.89%)	0.66	(1.36%)	2.28	(4.67%)	0.98	(2.00%)	12.09	(24.75%)	48.84	(100%)
Leng Ju Chao capsule	Bottle (100 caps.)	27.87	(47.87%)	12.40	(21.30%)	0.77	(1.32%)	1.94	(3.33%)	0.83	(1.43%)	14.41	(24.75%)	58.21	(100%)
Krachai Dum capsule	Bottle (100 caps.)	56.50	(60.07%)	12.00	(12.76%)	0.60	(0.63%)	1.18	(1.25%)	0.51	(0.54%)	23.29	(24.75%)	94.07	(100%)
Asiatic Pennywort capsule	Bottle (100 caps.)	29.22	(49.26%)	12.40	(20.90%)	0.77	(1.29%)	1.58	(2.66%)	0.67	(1.14%)	14.68	(24.75%)	59.31	(100%)
Garcinia capsule	Bottle (100 caps.)	34.79	(52.94%)	12.46	(18.97%)	1.19	(1.81%)	0.70	(1.07%)	0.30	(0.46%)	16.27	(24.75%)	65.72	(100%)
Wan Chuck Mod Luuk capsule	Bottle (100 caps.)	28.93	(50.45%)	12.17	(21.23%)	0.67	(1.17%)	0.96	(1.68%)	0.42	(0.72%)	14.19	(24.75%)	57.34	(100%)
Balsam Pear capsule	Bottle (100 caps.)	24.80	(45.36%)	12.05	(22.04%)	0.62	(1.13%)	2.57	(4.70%)	1.11	(2.02%)	13.54	(24.75%)	54.68	(100%)
Hemorrhoid pill	Bottle (1000 tabs.)	73.10	(33.01%)	64.59	(29.17%)	3.92	(1.77%)	17.39	(7.86%)	7.62	(3.44%)	54.81	(24.75%)	221.43	(100%)

Table 8: Unit cost of herbal products in the fiscal year 2003; classified by material, labor, and capital cost (continued)

Products	Unit	Direct production cost per unit						Quality control cost per unit				Indirect production cost per unit		Total cost per unit	
		Material		Labor		Capital		Labor		Capital					
Throranee Santhakaat pill	Bottle (200 tabs.)	15.45	(36.26%)	14.38	(33.75%)	0.77	(1.80%)	1.02	(2.39%)	0.45	(1.05%)	10.55	(24.75%)	42.62	(100%)
Hemorrhoid pill	Bottle (200 tabs.)	18.74	(39.76%)	14.38	(30.53%)	0.77	(1.62%)	1.09	(2.32%)	0.48	(1.02%)	11.66	(24.75%)	47.12	(100%)
Pra Sa Pai pill	Bottle (200 tabs.)	10.31	(29.36%)	14.14	(40.24%)	0.66	(1.88%)	0.92	(2.62%)	0.40	(1.15%)	8.70	(24.75%)	35.13	(100%)
Lime lozenge	Bottle (100 tabs.)	6.70	(54.53%)	2.31	(18.83%)	0.23	(1.89%)	-	(0.00%)	-	(0.00%)	3.04	(24.75%)	12.29	(100%)
Prunus lozenge	Bottle (100 tabs.)	7.68	(56.51%)	2.31	(17.03%)	0.23	(1.71%)	-	(0.00%)	-	(0.00%)	3.36	(24.75%)	13.59	(100%)
Clove lozenge	Bottle (100 tabs.)	9.33	(59.12%)	2.31	(14.66%)	0.23	(1.47%)	-	(0.00%)	-	(0.00%)	3.91	(24.75%)	15.78	(100%)
Vernonia in sachet	Box (30 sachets)	11.29	(39.46%)	8.72	(30.47%)	0.63	(2.19%)	0.62	(2.18%)	0.27	(0.95%)	7.08	(24.75%)	28.61	(100%)
Safflower in sachet	Box (30 sachets)	22.24	(51.84%)	8.50	(19.81%)	0.53	(1.24%)	0.70	(1.64%)	0.31	(0.72%)	10.62	(24.75%)	42.90	(100%)
Rang Jurd in sachet	Box (30 sachets)	14.11	(39.50%)	9.42	(26.39%)	0.93	(2.60%)	1.68	(4.71%)	0.73	(2.05%)	8.84	(24.75%)	35.72	(100%)
Roselle in sachet	Box (30 sachets)	16.66	(40.67%)	9.42	(23.01%)	0.93	(2.27%)	2.66	(6.50%)	1.15	(2.80%)	10.14	(24.75%)	40.96	(100%)
Cat's Whisker in sachet	Box (30 sachets)	13.94	(39.11%)	9.37	(26.30%)	0.91	(2.55%)	1.81	(5.09%)	0.79	(2.20%)	8.82	(24.75%)	35.65	(100%)
Senna in sachet	Box (30 sachets)	14.26	(44.49%)	8.26	(25.78%)	0.43	(1.34%)	0.81	(2.53%)	0.35	(1.11%)	7.93	(24.75%)	32.05	(100%)
Vernonia in sachet	Pack (10 sachets)	3.40	(23.02%)	6.78	(46.01%)	0.22	(1.51%)	0.48	(3.28%)	0.21	(1.43%)	3.65	(24.75%)	14.75	(100%)
Safflower in sachet	Pack (10 sachets)	7.70	(37.31%)	6.71	(32.53%)	0.19	(0.93%)	0.64	(3.12%)	0.28	(1.36%)	5.11	(24.75%)	20.63	(100%)
Rang Jurd in sachet	Pack (10 sachets)	4.99	(25.93%)	7.02	(36.49%)	0.32	(1.68%)	1.50	(7.77%)	0.65	(3.38%)	4.76	(24.75%)	19.24	(100%)
Roselle in sachet	Pack (10 sachets)	5.84	(25.64%)	7.02	(30.83%)	0.32	(1.42%)	2.76	(12.13%)	1.19	(5.23%)	5.64	(24.75%)	22.77	(100%)
Cat's Whisker in sachet	Pack (10 sachets)	5.23	(26.49%)	7.00	(35.45%)	0.32	(1.60%)	1.62	(8.17%)	0.70	(3.54%)	4.89	(24.75%)	19.75	(100%)
Senna in sachet	Pack (10 sachets)	5.04	(29.59%)	6.63	(38.97%)	0.16	(0.93%)	0.68	(4.01%)	0.30	(1.75%)	4.21	(24.75%)	17.02	(100%)
Chaa Phluu in sachet	Pack (10 sachets)	4.72	(27.22%)	6.89	(39.77%)	0.27	(1.55%)	0.81	(4.69%)	0.35	(2.02%)	4.29	(24.75%)	17.33	(100%)
Lemon Glass in sachet	Pack (10 sachets)	5.82	(25.55%)	7.43	(32.59%)	0.50	(2.19%)	2.38	(10.44%)	1.02	(4.48%)	5.64	(24.75%)	22.79	(100%)
Ginger in sachet	Pack (10 sachets)	5.84	(30.37%)	7.02	(36.53%)	0.32	(1.69%)	0.89	(4.64%)	0.39	(2.02%)	4.76	(24.75%)	19.22	(100%)
Cinnamomum Stomachic	Bottle (180 ml.)	3.44	(29.40%)	5.30	(45.26%)	0.04	(0.33%)	0.02	(0.18%)	0.01	(0.08%)	2.90	(24.75%)	11.71	(100%)
Ya Hom Nawagaoth	Bottle (30 g.)	10.22	(46.73%)	5.61	(25.66%)	0.63	(2.86%)	-	(0.00%)	-	(0.00%)	5.41	(24.75%)	21.87	(100%)
Tong Pun Chung tincture	Bottle (30 ml.)	6.00	(37.81%)	5.30	(33.41%)	0.04	(0.25%)	0.42	(2.65%)	0.18	(1.13%)	3.93	(24.75%)	15.86	(100%)
Paya Yor tincture	Bottle (30 ml.)	6.16	(40.07%)	5.30	(34.45%)	0.04	(0.25%)	0.05	(0.34%)	0.02	(0.14%)	3.81	(24.75%)	15.39	(100%)
Paya Yor glycerine	Bottle (5 ml.)	9.04	(43.92%)	6.34	(30.78%)	0.04	(0.19%)	0.05	(0.25%)	0.02	(0.11%)	5.09	(24.75%)	20.58	(100%)
Mosquito repellent	Spray (60 ml.)	22.45	(63.17%)	4.27	(12.00%)	0.03	(0.08%)	-	(0.00%)	-	(0.00%)	8.80	(24.75%)	35.55	(100%)
Paya Yor balm	Bottle (10 g.)	7.42	(34.50%)	8.65	(40.26%)	0.03	(0.14%)	0.05	(0.25%)	0.02	(0.10%)	5.32	(24.75%)	21.50	(100%)

Table 8: Unit cost of herbal products in the fiscal year 2003; classified by material, labor, and capital cost (continued)

Products	Unit	Direct production cost per unit						Quality control cost per unit				Indirect production cost per unit		Total cost per unit	
		Material		Labor		Capital		Labor		Capital					
Paya Yor calamine	Bottle (60 ml.)	4.94	(35.88%)	5.30	(38.48%)	0.05	(0.35%)	0.05	(0.38%)	0.02	(0.16%)	3.41	(24.75%)	13.77	(100%)
Guava mouth wash	Bottle (200 ml.)	8.74	(14.03%)	38.10	(61.14%)	0.05	(0.08%)	-	(0.00%)	-	(0.00%)	15.42	(24.75%)	62.31	(100%)
Mouth deodorant spray	Spray (60 ml.)	15.51	(27.36%)	27.12	(47.84%)	0.03	(0.05%)	-	(0.00%)	-	(0.00%)	14.03	(24.75%)	56.70	(100%)
Herbal Steam Bath (plastic bag)	Pack	8.35	(31.60%)	11.51	(43.54%)	0.03	(0.11%)	-	(0.00%)	-	(0.00%)	6.54	(24.75%)	26.44	(100%)
Herbal Steam Bath (cloth bag)	Pack	18.29	(44.59%)	12.55	(30.59%)	0.03	(0.07%)	-	(0.00%)	-	(0.00%)	10.15	(24.75%)	41.01	(100%)
Herbal Compress	Pack	18.38	(34.80%)	21.33	(40.39%)	0.03	(0.06%)	-	(0.00%)	-	(0.00%)	13.07	(24.75%)	52.80	(100%)
Blu Pea shampoo	Bottle (250 ml.)	27.96	(59.26%)	7.49	(15.89%)	0.05	(0.10%)	-	(0.00%)	-	(0.00%)	11.68	(24.75%)	47.18	(100%)
Aloe & Leech Lime shampoo	Bottle (250 ml.)	22.18	(56.16%)	7.49	(18.97%)	0.05	(0.12%)	-	(0.00%)	-	(0.00%)	9.78	(24.75%)	39.50	(100%)
Betel & Leech Lime shampoo	Bottle (250 ml.)	21.51	(55.72%)	7.49	(19.41%)	0.05	(0.12%)	-	(0.00%)	-	(0.00%)	9.56	(24.75%)	38.62	(100%)
Soapberry shampoo	Bottle (250 ml.)	20.93	(55.31%)	7.49	(19.81%)	0.05	(0.13%)	-	(0.00%)	-	(0.00%)	9.37	(24.75%)	37.84	(100%)
Ginger shampoo	Bottle (250 ml.)	21.30	(54.80%)	7.49	(19.28%)	0.05	(0.12%)	0.29	(0.74%)	0.12	(0.31%)	9.62	(24.75%)	38.87	(100%)
Borapet shampoo	Bottle (250 ml.)	21.06	(52.43%)	7.49	(18.67%)	0.05	(0.12%)	1.13	(2.83%)	0.48	(1.20%)	9.94	(24.75%)	40.15	(100%)
Blu Pea hair conditioner	Bottle (250 ml.)	10.41	(43.64%)	7.49	(31.41%)	0.05	(0.20%)	-	(0.00%)	-	(0.00%)	5.91	(24.75%)	23.86	(100%)
Aloe & Leech Lime hair conditioner	Bottle (250 ml.)	9.91	(42.73%)	7.49	(32.31%)	0.05	(0.21%)	-	(0.00%)	-	(0.00%)	5.74	(24.75%)	23.20	(100%)
Betel & Leech Lime hair conditioner	Bottle (250 ml.)	9.53	(42.00%)	7.49	(33.04%)	0.05	(0.21%)	-	(0.00%)	-	(0.00%)	5.62	(24.75%)	22.69	(100%)
Soapberry hair conditioner	Bottle (250 ml.)	9.57	(42.08%)	7.49	(32.96%)	0.05	(0.21%)	-	(0.00%)	-	(0.00%)	5.63	(24.75%)	22.74	(100%)
Ginger hair conditioner	Bottle (250 ml.)	10.68	(43.14%)	7.49	(30.27%)	0.05	(0.19%)	0.29	(1.16%)	0.12	(0.49%)	6.13	(24.75%)	24.76	(100%)
Borapet hair conditioner	Bottle (250 ml.)	10.68	(40.52%)	7.49	(28.42%)	0.05	(0.18%)	1.13	(4.30%)	0.48	(1.83%)	6.53	(24.75%)	26.37	(100%)
Mangosteen liquid soap	Bottle (250 ml.)	34.87	(66.97%)	4.27	(8.19%)	0.05	(0.09%)	-	(0.00%)	-	(0.00%)	12.89	(24.75%)	52.08	(100%)
Tumeric liquid soap	Bottle (250 ml.)	34.87	(66.97%)	4.27	(8.19%)	0.05	(0.09%)	-	(0.00%)	-	(0.00%)	12.89	(24.75%)	52.08	(100%)

Table 9: Production cost, revenue, and comparison of cost and revenue of herbal production

Products	Unit	Production quantity	Unit cost	Wholesale price	Production cost	Revenue	Revenue - cost	Revenue / cost
Tumeric capsule	Bottle (1000 caps.)	11	375.30	320.00	4,128.31	3,520.00	-608.31	0.85
Fa Ta Lai capsule	Bottle (1000 caps.)	3	354.13	320.00	1,062.40	960.00	-102.40	0.90
Appetite Reducing capsule	Bottle (1000 caps.)	12	336.13	450.00	4,033.55	5,400.00	1,366.45	1.34
Sahat Thara capsule	Bottle (1000 caps.)	7	383.78	350.00	2,686.49	2,450.00	-236.49	0.91
Lin-Zhi capsule	Bottle (1000 caps.)	3	530.33	600.00	1,590.99	1,800.00	209.01	1.13
Increase Longevity capsule	Bottle (1000 caps.)	32	308.17	320.00	9,861.60	10,240.00	378.40	1.04
Wan Chuck Mod Luuk capsule	Bottle (1000 caps.)	9	408.22	415.00	3,674.00	3,735.00	61.00	1.02
Balsam Pear capsule	Bottle (1000 caps.)	6	383.05	320.00	2,298.32	1,920.00	-378.32	0.84
Garcinia capsule	Bottle (1000 caps.)	3	525.68	650.00	1,577.05	1,950.00	372.95	1.24
Tumeric capsule	Bottle (100 caps.)	2,109	51.83	50.00	109,302.66	105,450.00	-3,852.66	0.96
Khee Lek capsule	Bottle (100 caps.)	630	46.29	50.00	29,160.18	31,500.00	2,339.82	1.08
Borapet capsule	Bottle (100 caps.)	719	48.79	50.00	35,083.13	35,950.00	866.87	1.02
Petsangkhaat capsule	Bottle (100 caps.)	1,484	49.43	50.00	73,348.54	74,200.00	851.46	1.01
Fa Ta Lai capsule	Bottle (100 caps.)	1,912	49.25	50.00	94,163.17	95,600.00	1,436.83	1.02
Luuk Tai Bai capsule	Bottle (100 caps.)	452	46.32	50.00	20,934.81	22,600.00	1,665.19	1.08
Appetite Reducing capsule	Bottle (100 caps.)	2,326	46.87	93.00	109,009.88	216,318.00	107,308.12	1.98
Sahat Thara capsule	Bottle (100 caps.)	1,962	53.56	50.00	105,075.99	98,100.00	-6,975.99	0.93
Sea Holly & Pepper capsule	Bottle (100 caps.)	1,040	52.02	50.00	54,099.18	52,000.00	-2,099.18	0.96
Lin-Zhi capsule	Bottle (100 caps.)	1,944	65.74	100.00	127,794.79	194,400.00	66,605.21	1.52
Increase Longevity capsule	Bottle (100 caps.)	1,530	46.29	50.00	70,820.48	76,500.00	5,679.52	1.08
Indian Mulberry capsule	Bottle (100 caps.)	794	48.84	50.00	38,777.44	39,700.00	922.56	1.02
Leng Ju Chao capsule	Bottle (100 caps.)	1,078	58.21	50.00	62,750.27	53,900.00	-8,850.27	0.86
Krachai Dum capsule	Bottle (100 caps.)	296	94.07	200.00	27,844.88	59,200.00	31,355.12	2.13
Asiatic Pennywort capsule	Bottle (100 caps.)	530	59.31	57.00	31,433.93	30,210.00	-1,223.93	0.96
Garcinia capsule	Bottle (100 caps.)	1,594	65.72	65.00	104,750.35	103,610.00	-1,140.35	0.99
Wan Chuck Mod Luuk capsule	Bottle (100 caps.)	2,238	57.34	52.00	128,337.31	116,376.00	-11,961.31	0.91

Table 9: Production cost, revenue, and comparison of cost and revenue of herbal production (continued)

Products	Unit	Production quantity	Unit cost	Wholesale price	Production cost	Revenue	Revenue – cost	Revenue / cost
Balsam Pear capsule	Bottle (100 caps.)	537	54.68	50.00	29,364.23	26,850.00	-2,514.23	0.91
Hemorrhoid pill	Bottle (1000 tabs.)	8	221.43	198.00	1,771.47	1,584.00	-187.47	0.89
Throranee Santhakaat pill	Bottle (200 tabs.)	409	42.62	50.00	17,432.19	20,450.00	3,017.81	1.17
Hemorrhoid pill	Bottle (200 tabs.)	509	47.12	50.00	23,984.91	25,450.00	1,465.09	1.06
Pra Sa Pai pill	Bottle (200 tabs.)	453	35.13	50.00	15,915.83	22,650.00	6,734.17	1.42
Lime lozenge	Bottle (100 tabs.)	1,435	12.29	10.00	17,636.13	14,350.00	-3,286.13	0.81
Prunus lozenge	Bottle (100 tabs.)	2,215	13.59	10.00	30,091.64	22,150.00	-7,941.64	0.74
Clove lozenge	Bottle (100 tabs.)	2,168	15.78	10.00	34,205.45	21,680.00	-12,525.45	0.63
Vernonia in sachet	Box (30 sachets)	1,852	28.61	40.00	52,978.17	74,080.00	21,101.83	1.40
Safflower in sachet	Box (30 sachets)	4,596	42.90	49.00	197,189.81	225,204.00	28,014.19	1.14
Rang Jurd in sachet	Box (30 sachets)	857	35.72	40.00	30,612.53	34,280.00	3,667.47	1.12
Roselle in sachet	Box (30 sachets)	425	40.96	40.00	17,408.30	17,000.00	-408.30	0.98
Cat's Whisker in sachet	Box (30 sachets)	814	35.65	40.00	29,017.18	32,560.00	3,542.82	1.12
Senna in sachet	Box (30 sachets)	1,949	32.05	40.00	62,459.79	77,960.00	15,500.21	1.25
Vernonia in sachet	Pack (10 sachets)	200	14.75	12.00	2,949.27	2,400.00	-549.27	0.81
Safflower in sachet	Pack (10 sachets)	706	20.63	17.00	14,566.96	12,002.00	-2,564.96	0.82
Rang Jurd in sachet	Pack (10 sachets)	338	19.24	12.00	6,501.97	4,056.00	-2,445.97	0.62
Roselle in sachet	Pack (10 sachets)	321	22.77	12.00	7,309.29	3,852.00	-3,457.29	0.53
Cat's Whisker in sachet	Pack (10 sachets)	421	19.75	12.00	8,316.26	5,052.00	-3,264.26	0.61
Senna in sachet	Pack (10 sachets)	336	17.02	12.00	5,718.32	4,032.00	-1,686.32	0.71
Chaa Phluu in sachet	Pack (10 sachets)	343	17.33	12.00	5,944.35	4,116.00	-1,828.35	0.69
Lemon Glass in sachet	Pack (10 sachets)	468	22.79	12.00	10,666.06	5,616.00	-5,050.06	0.53
Ginger in sachet	Pack (10 sachets)	345	19.22	12.00	6,629.49	4,140.00	-2,489.49	0.62
Cinnamomum Stomachic	Bottle (180 ml.)	6,522	11.71	7.00	76,382.94	45,654.00	-30,728.94	0.60
Ya Hom Nawagaoth	Bottle (30 g.)	928	21.87	21.00	20,290.87	19,488.00	-802.87	0.96
Tong Pun Chung tincture	Bottle (30 ml.)	994	15.86	10.00	15,767.89	9,940.00	-5,827.89	0.63

Table 9: Production cost, revenue, and comparison of cost and revenue of herbal production (continued)

Products	Unit	Production quantity	Unit cost	Wholesale price	Production cost	Revenue	Revenue - cost	Revenue / cost
Paya Yor tincture	Bottle (30 ml.)	836	15.39	11.00	12,863.71	9,196.00	-3,667.71	0.71
Paya Yor glycerine	Bottle (5 ml.)	813	20.58	18.00	16,731.14	14,634.00	-2,097.14	0.87
Mosquito repellent	Spray (60 ml.)	95	35.55	47.00	3,376.99	4,465.00	1,088.01	1.32
Paya Yor balm	Bottle (10 g.)	459	21.50	15.00	9,866.61	6,885.00	-2,981.61	0.70
Paya Yor calamine	Bottle (60 ml.)	564	13.77	10.00	7,767.65	5,640.00	-2,127.65	0.73
Guava mouth wash	Bottle (200 ml.)	592	62.31	22.00	36,885.37	13,024.00	-23,861.37	0.35
Mouth deodorant spray	Spray (60 ml.)	58	56.70	20.00	3,288.42	1,160.00	-2,128.42	0.35
Herbal Steam Bath (plastic bag)	Pack	491	26.44	21.00	12,981.09	10,311.00	-2,670.09	0.79
Herbal Steam Bath (cloth bag)	Pack	299	41.01	38.00	12,263.27	11,362.00	-901.27	0.93
Herbal Compress	Pack	2,357	52.80	38.00	124,460.69	89,566.00	-34,894.69	0.72
Blu Pea shampoo	Bottle (250 ml.)	559	47.18	36.00	26,374.55	20,124.00	-6,250.55	0.76
Aloe & Leech Lime shampoo	Bottle (250 ml.)	235	39.50	36.00	9,282.77	8,460.00	-822.77	0.91
Betel & Leech Lime shampoo	Bottle (250 ml.)	79	38.62	36.00	3,050.60	2,844.00	-206.60	0.93
Soapberry shampoo	Bottle (250 ml.)	309	37.84	36.00	11,692.54	11,124.00	-568.54	0.95
Ginger shampoo	Bottle (250 ml.)	75	38.87	38.00	2,915.25	2,850.00	-65.25	0.98
Borapet shampoo	Bottle (250 ml.)	146	40.15	38.00	5,862.60	5,548.00	-314.60	0.95
Blu Pea hair conditioner	Bottle (250 ml.)	298	23.86	30.00	7,111.07	8,940.00	1,828.93	1.26
Aloe & Leech Lime hair conditioner	Bottle (250 ml.)	141	23.20	30.00	3,270.94	4,230.00	959.06	1.29
Betel & Leech Lime hair conditioner	Bottle (250 ml.)	66	22.69	30.00	1,497.35	1,980.00	482.65	1.32
Soapberry hair conditioner	Bottle (250 ml.)	130	22.74	30.00	2,955.96	3,900.00	944.04	1.32
Ginger hair conditioner	Bottle (250 ml.)	66	24.76	30.00	1,634.37	1,980.00	345.63	1.21
Borapet hair conditioner	Bottle (250 ml.)	117	26.37	30.00	3,085.20	3,510.00	424.80	1.14
Mangosteen liquid soap	Bottle (250 ml.)	84	52.08	42.00	4,374.51	3,528.00	-846.51	0.81
Tumeric liquid soap	Bottle (250 ml.)	81	52.08	42.00	4,218.27	3,402.00	-816.27	0.81
Total					**2,322,521.92**	**2,422,848.00**	**100,326.08**	**1.04**

1.6 Sensitivity analysis on discount rate and prices of materials used in production process

Due to the uncertainty of discount rate and prices of materials used in production process , The results were analyzed and were presented as the followings.

1.6.1 The uncertainty of discount rate

Net benefit and benefit cost ratio were recalculated when the discount rate was varied as 0% and 3%. In case of using discount rate as 0%, the results indicated that net benefit increased by 12.96% ,and benefit to cost ratio increased from 1.0432 to 1.0491. Conversely, when discount rate was 3%, net benefit decreased by 8.46%, and benefit to cost ratio decreased from 1.0432 to 1.0394. The details are shown in table 10.

1.6.2 The uncertainty of prices of materials used in production process

Because of using the prices of materials used in production process at the end of a fiscal year, the affect of their prices were used in calculation. The estimation of material price change conducted by drug inventory staff was used to calculate. When the prices decreased by 10%, the results shown that net benefit increased by 122.31%, and benefit to cost ratio increased from 1.0432 to 1.1014. In contrast, if the prices increased by 10%, net benefit decreased by 123.46% that making a negative result, and benefit to cost ratio decreased from 1.0432 to 0.9904. The details are shown in table 11.

Table 10: Results of sensitivity analysis on discount rate

Discount rate	1.86% (Based case)	Simulated discount rate	
		0%	3%
Production cost	2,322,521.92	2,309,518.28	2,331,008.18
Revenue	2,422,848.00	2,422,848.00	2,422,848.00
Net benefit	100,326.08	113,329.72	91,839.82
		(12.96%)	(-8.46%)
Benefit to cost ratio	1.0432	1.0491	1.0394

Table 11: Results of sensitivity analysis on prices of materials used in production process

Prices of materials	The prices at the end of a fiscal year (Based case)	Simulated prices of materials	
		Decrease 10%	Increase 10%
Production cost	2,322,521.92	2,199,813.77	2,446,382.66
Revenue	2,422,848.00	2,422,848.00	2,422,848.00
Net benefit	100,326.08	223,034.23	-23,534.66
		(122.31%)	(-123.46%)
Benefit to cost ratio	1.0432	1.1014	0.9904

2. Payback Period Determination

2.1 Payback period

In this part, the herbal production cost was recalculated by excluding the opportunity costs of land and stocked materials and depreciation cost of buildings and durable goods, and then including the current asset values of buildings and durable goods. The results shown that the herbal production cost in the fiscal year 2003 was 2,802,642.20 baht. When it was compared with the revenue, 2,422,848.00 baht, the results indicated that the loss of program in the fiscal year 2003 was 379,794.20 baht.

To analyze the time required for recovery the initial cost in the fiscal year 2003, it needs to know costs and revenues in the following years. For this reason, the forecasted revenues were analyzed by using simple linear regression, and then the estimated costs were analyzed by using ratio of cost to revenue in the fiscal year 2003. The results shown that the forecasted revenues in the fiscal year 2004 and 2005 were 2,756,512.11 baht and 2,812,540.49 baht, respectively, and the estimated costs in the fiscal year 2004 and 2005 were 2,485,221.65 baht and 2,535,735.83 baht, respectively.

Later, the net benefit in the following years were calculated. The results shown that the program was profitable in the fiscal year 2004 and 2005, and then these profits were discounted at the fiscal year 2003 by using discount rate as 1.86%. Finally, the discounted net benefits were summed until a positive result was obtained. As the results, the payback period of the herbal production was 2 years and 6 months. The details are shown in table 12.

2.2 Sensitivity analysis on asset values

Due to the fiscal year 2003 was not the beginning year of herbal production establishment, the replacement values were used as asset values. Therefore, if herbal production was assumed to be the new investment in the fiscal year 2003, the asset values were calculated based on replacement prices. The simulated replacement values were used to recalculate and found that the payback period was longer to 6 years and 5 months, as shown in table 13.

2.3 Sensitivity analysis on number of services

In case of revenue forecasting, the number of services was used as independent variable to forecast the revenue from the simple linear regression equation. Therefore, the results might be changed from the uncertainty of number of services. So, the payback period was recalculated when the number of services decreased by 10% and increased by 10%. The results shown that the payback period was 2 years and 7 months if the number of services decreased by 10% whereas it was 2 years and 5 months when the number of services increased by 10%, as shown in table 14.

Table 12: Results of payback analysis

Description	Fiscal year 2003	Fiscal year 2004	Fiscal year 2005
Revenue	2,422,848.00	2,756,512.11	2,812,540.49
Production cost	2,184,396.10	2,485,221.65	2,535,735.83
- Direct material cost	1,058,868.14	1,204,690.86	1,229,177.19
- Direct labor cost	641,510.99	729,857.10	744,692.05
- Other production costs	484,016.97	550,673.69	561,866.59
Assets	618,246.10	-	-
Total cost	2,802,642.20	2,485,221.65	2,535,735.83
Net benefit	- 379,794.20	271,290.46	276,804.66
Discounted net benefit	- 379,794.20	266,336.60	266,787.85
Sum of discounted net benefit	- 379,794.20	- 113,457.60	153,330.25
Payback period			2 years and 6 months

Table 13: Results of sensitivity analysis on asset values of payback period

Description	Fiscal year 2003	Fiscal year 2004	Fiscal year 2005	Fiscal year 2006	Fiscal year 2007	Fiscal year 2008	Fiscal year 2009
Revenue	2,422,848.00	2,756,512.11	2,812,540.49	2,870,619.50	2,930,824.21	2,993,232.40	3,057,924.73
Production cost	2,184,396.10	2,485,221.65	2,535,735.83	2,588,098.82	2,642,378.30	2,698,644.40	2,756,969.84
- Direct material cost	1,058,868.14	1,204,690.86	1,229,177.19	1,254,559.72	1,280,871.26	1,308,145.79	1,336,418.57
- Direct labor cost	641,510.99	729,857.10	744,692.05	760,069.95	776,010.69	792,534.85	809,663.80
- Other production costs	484,016.97	550,673.69	561,866.59	573,469.15	585,496.35	597,963.76	610,887.47
Assets (Replacement prices)	1,693,951.94	-	-	-	-	-	-
Total cost	3,878,348.04	2,485,221.65	2,535,735.83	2,588,098.82	2,642,378.30	2,698,644.40	2,756,969.84
Net benefit	- 1,455,500.04	271,290.46	276,804.66	282,520.68	288,445.91	294,588.00	300,954.89
Discounted net benefit	- 1,455,500.04	266,336.60	266,787.85	267,324.78	272,931.32	278,743.04	284,767.47
Sum of discounted net benefit	- 1,455,500.04	- 1,189,163.44	- 922,375.59	- 655,050.81	- 382,119.49	- 103,376.45	181,391.02
Payback period							6 years and 5 months

Table 14: Results of sensitivity analysis on number of services of payback period

Numbers of services	Based case	Simulated numbers of services	
		Decreased by 10 %	Increased by 10 %
Payback period	2 years and 6 months	2 years and 7 months	2 years and 5 months

3. Productivity Evaluation

Similarly to payback period determination, the herbal production cost was recalculated by excluding the opportunity costs of land and stocked materials. While the depreciation costs of buildings and durable goods were still included, but the calculation method was changed to accounting based approach. The results of productivity evaluation consisted of cost management, financial management, and performance ratios. The details are presented in table 15.

In case of cost management ratios, the results shown that the percentage of material cost, production labor cost, and depreciation cost were higher than their industrial averages, while the percentage of utility and energy cost was lower. In part of financial management ratios, operating profit to sales ratio was equal to the industrial average, but gross profit to sales ratio was lower. For inventory turnover, it was higher than its industrial average. When the inventory elements were evaluated, goods in process turnover and product turnover were higher, while raw materials turnover was lower. The last indicator group that was performance ratios, the results indicated that amount of production per employee and amount of processing per employee were lower than their industrial averages, but efficiency of machinery investment ratio, material cost to production value ratio, and labor cost to production value ratio were higher.

From the results were described above, it meant that the herbal production at U-thong Hospital was the labor intensive industry due to high production labor cost, low performance per employee, and high performance per machinery and equipment value. For the ability on generating profit, it was equal to other manufacturers but consumed more production cost. For inventory management, it was more efficiency on goods in process and finished goods, but raw materials were over stock.

Table 15: Results of productivity evaluation

Indicators	Industrial average *	Production unit at U-thong Hospital	Comparison with industrial average
Cost Management Ratios			
% of Material cost	43.79	46.45	+
% of Production labor cost	6.77	28.14	+
% of Depreciation cost	1.48	4.17	+
% of Utility & energy cost	6.43	2.42	-
Financial Management Ratios			
Operating profit to sales ratio	0.06	0.06	=
Gross profit to sales ratio	0.24	0.15	-
Inventory turnover (Time)	2.48	5.59	+
Raw materials turnover (Time)	10.85	7.91	-
Goods in process turnover (Time)	4.27	104.17	+
Product turnover (Time)	12.96	23.31	+
Performance Ratios			
Amount of production per employee (Baht)	925,526.40	382,360.83	-
Amount of processing per employee (Baht)	527,837.71	181,249.69	-
Efficiency of machinery investment ratio	3.48	20.92	+
Material cost to production value ratio	0.44	0.51	+
Labor cost to production value ratio	0.07	0.31	+

+ More than, = Equal, and - Less than

* The data came from 14 samples of small drug industry in the year 2001, reported by the Thailand Productivity Institute.

CHAPTER 5
DISCUSSION

In this study, the efficiency of herbal production in U-thong Hospital was evaluated by conducting cost-benefit analysis, payback period determination, and productivity evaluation. The results were discussed on four main points as the followings.

1. Cost-benefit analysis
2. Payback period determination
3. Productivity evaluation
4. Generalization of the results

1. Cost-Benefit Analysis

Cost-benefit analysis as a technique of economic evaluation is used to evaluate the worthiness of the program. The results are usually presented into two forms i.e. net benefit and benefit to cost ratio. If net benefit is greater than zero, and benefit to cost ratio is greater than one, it indicates that the program is worthwhile.(15, 17, 24) According to the results of this study, in the fiscal year 2003, the cost of herbal production was 2,322,521.92 baht, and the revenue from sales was 2,422,848.00 baht. So, the net benefit was 100,326.08 baht, and benefit to cost ratio was 1.04. Therefore, it could be indicated that the herbal production at U-thong Hospital was worthwhile.

According to results by product items, the high net benefit products such as Appetite Reducing capsule (100 caps.), Lin-Zhi capsule (100 caps.), and Krachai Dum capsule (100 caps.) should be interested to increase production. In contrast, the low net benefit products such as Herbal Compress, Cinnamomum Stomachic, and Guava mouth wash should be concerned on reducing costs, increasing appropriate prices, or stop production. These results are useful for production plan and price revision.

Considering the methodology of cost calculation used in this study, it was standard method that was widely used in hospital cost calculation. It covers both direct and indirect costs. For indirect costs, the most accurate simultaneous equation method was used to allocate costs from transient cost centers (TCCs) to absorbing cost centers (ACCs). Also, for unit cost calculation, the most accurate micro-costing method was used to allocate cost from production cost centers to individual products. Moreover, the micro-costing covered from the beginning to the end of process, such as herb powder preparing, compounding, and quality control. Therefore, the methods employed in this study were appropriate to obtain the reliable and accurate results.(16, 18, 26)

However, there were some shortcomings affecting to the accuracy of the results. There were allocation criteria selected in indirect cost determination, data collection in unit cost calculation, and the discount rate used in depreciation cost calculation and the prices of materials used in material cost calculation in unit cost calculation. They were described as the followings.

1.1 Allocation criteria selected in indirect cost determination

Due to the production unit is one of the departments in the hospital, so it is necessary to receive costs allocated from TCCs. These allocated costs are possible to be varied due to different allocation criteria that used in indirect cost calculation. Therefore, in case of TCCs having several outputs, the selection of outputs to be used as allocation criteria is important because the inappropriate criteria lead to less accurate results. In general, the concepts of allocation criteria selection are to consider which output most reflects resource utilization and data availability.(16, 26) In this study, due to limitation of study time, budget, and availability of data, some allocation criteria employed might not be most appropriate because they less reflected the service utilization. For example, indirect cost from the tap water and sewage disposal unit should be allocated based on the volume of water used by the departments as the allocation criterion, instead of the number of departments' staff. For this reason, some cost centers such as central supply, laundry, and production unit, which used tap water in their work but less staff, would have less indirect costs than it should be.

However, the selected criteria in this study should be accepted because the full cost of tap water and sewage disposal unit was only 1.42% of total hospital cost. Therefore, it might not be worthwhile to sacrifice more effort for very little change in the results.

1.2 Data collection in unit cost calculation

To calculate the cost of herbal production, unit costs of products were calculated by using micro-costing method. The concept of this method is the attempt to determine direct cost of each product, and then allocates indirect cost to each product by using proportion of the direct cost.(18) Direct cost of each product consisted of material cost, labor cost, and depreciation cost. Working formula were used to calculate material cost. For labor and depreciation cost, time spent of labor and equipment were used to calculate. Due to unavailability of data, time spent was established by estimation made by staff of the production unit. So, these data might be far from being consistent. Generally, work measurement technique e.g. time study should be employed to have more accurate labor and equipment time used.(39, 40)

1.3 The uncertainty of discount rate and prices of materials used in production process

The discount rate comes in primarily because of time preference and opportunity cost when we consider the choices between now and the future cost and benefit. Normally, economists believe that people have preference for present consumption than future. If we spend money in the current time period, we forego the opportunity of investing this money. The notion of time preference implies that future cost and benefit are worth less, and hence discounted more, to reflect individual and societal preferences to have resources and money now rather than in the future. Discounting is also useful to compute an annual equivalent cost.(27) In this study, the interest rate of 12-momth fixed deposit, 1.86 percent, was used as the discount rate in depreciation cost calculation.(34, 35) Due to the selection of the discount rate was difficult, sensitivity analysis was conducted for analyzing the affect of different discount rates. In the first scenario, the discount rate was assumed to be zero.

Another rate was 3%, which has been extensively used and recommended.(27) From the results, when the discount rate varied from 0 – 3%, net benefit varied from 113,329.72 – 91,839.82 baht, and benefit to cost ratio varied from 1.0491 – 1.0394. Therefore, the herbal production was still worthwhile and had little difference of the results when the discount rate varied from 0 – 3%. In other words, the depreciation costs of buildings and durable goods were little (5.79% of the hospital cost), so the variation of depreciation cost did not significantly affect to the overall results.

For the prices of materials used in production process, they were varied throughout the year. Because of limitation of study time, their prices at the end of a fiscal year 2003 were used to calculate direct material cost in unit cost calculation. Simulated price variation was used to analyze the uncertainty. The estimation of material price change conducted by drug inventory staff was used to calculate. According to the results, if the prices decreased by 10%, net benefit increased by 122.31%, and benefit to cost ratio increased from 1.0432 to 1.1014. Conversely, if the prices increased by 10%, net benefit decreased by 123.46% that making a negative result, and benefit to cost ratio decreased from 1.0432 to 0.9904. Therefore, the changes of the prices of materials used in production process as ±10% made significantly affect to the overall results. Especially, when they increased up to 10%, the herbal production was not profitable due to herbal production cost was increased. So, these results suggested that the efficiency on inventory control should be concerned to control the purchasing prices of materials

In brief, the uncertainty of discount rate did not significantly affect to the overall results, but the increase of the prices of materials used in production process could make the loss to herbal production. This simulation was useful to control the cost of herbal production.

2. Payback Period Determination

Payback method is generally used in business organizations to determine how long they will take to recover the initial investment. In general, most organizations using the payback method have chosen some acceptable periods, such as three or four years, and reject all projects that have payback period longer than the selected one.(19,

37) According to the results of this study, the payback period was 2 years and 6 months, which were in the acceptable range, and assumed that the return period of the program investment was rather short.

However, there were two problems affecting the accuracy of the results. The first was that the study time did not start from the initial year of the program establishment, and another was that the revenue forecasting equation was not quite accuracy. They were explained as the followings.

2.1 The beginning of the study time

To determine the payback period, the concept of payback method is to calculate from the beginning of the program investment. Because of limitation of data availability, this study was started to calculate at the fiscal year 2003, which was not the initial year of the production unit establishment. Before that year, the program might have accumulated profit or loss, which were not determined and recorded. For this reason, it needed to assume that profit or loss of program accumulated from the beginning to the fiscal year 2003 was zero. Moreover, in calculation the value of assets, they were calculated as the current value by subtracting the original price with the accumulated depreciation cost because most of them were not purchased at the fiscal year 2003, and some of them were used for more than their working years.

For this reason, the herbal production cost was underestimated. If the payback method was started at the beginning, the payback period might be longer. This is confirmed by a result in sensitivity analysis. When the replacement prices in the study year of 2003 were used as asset values, the payback period was 6 years and 5 months. This is an important for new investment. Particularly for private investment that uses loan for investment, production cost would be higher due to interest. This results in longer payback period than 6 years and 5 months.

2.2 The revenue forecasting equation

To calculate payback period, it needs to know the revenues in the following years. In this study, the expected revenue of the production unit came from selling herbal products to the pharmacy dispensing unit and the Thai traditional medicine

center. The pharmacy dispensing unit dispensed herbal products prescribed by modern doctors. The Thai traditional medicine center dispensed herbal products prescribed by ayuravedic doctors and directly sold to customers. There was no real purchasing between the production unit and the pharmacy dispensing unit, the Thai traditional medicine center. In addition, there was no data on revenue from the pharmacy dispensing unit. Therefore, there was no data on real revenue of the production unit. To forecast the expected revenue of the production unit, simple regression analysis was employed. The expected revenue was predicted based on association with the summation of total number of herbal prescriptions and number of customers at the Thai traditional medicine center. Although the value in each prescription and selling was different, but it was the best approach for analyzing the revenues in this study. However, the number of patients receiving herbal products prescribed by modern doctor at the hospital's outpatient department could not be obtained. Therefore, the independent variable was the number of services that included only the number of TTM services and the number of consumers directly buying herbal products at TTM center. Anyway, it should be accepted due to the value of herbal products dispensed at the hospital's outpatient department was only 8.61% of total herbal product value.

Regarding to the simple linear regression equation, the value of R square was 0.25, indicated that this equation could forecast the revenue accurately by 25%. The low accuracy might come from two reasons. The first reason is that the sample size in formulated equation was small. Another reason is that the revenue was varied by other variables e.g. different amount in each prescription. To obtain more accurate equation, it should be formulated by using more sample size and including other associated variables with multiple regression analysis.

Because the number of services was used as independent variable, the uncertainty was analyzed when it decreased by 10% and increased by 10%. It was found that the payback periods were still within three years. Therefore, the variation of the number of services as ±10% made the little change to the payback period.

3. Productivity Evaluation

The selection of criteria for efficiency comparison is important. Generally, the concept of index comparison can be divided in three ways.(41)

1) Comparison with several periods

2) Comparison with several departments

3) Comparison with the reference or standard that were set up from the good samples of that field.

In this study, productivity index formulated by the Thai Productivity Institute was used to evaluate the efficiency. Due to the unavailability of hospital data in the past years and the herbal production in other hospitals were never been evaluated, so the averages of small modern drug industry reported by the Thailand Productivity Institute were used as criteria for the comparison. These criteria came from 14 small modern drug manufacturers, where were included in 50 samples of all sizes of modern drug industry.(33) The samples were collected by convenience method from total 172 modern drug manufacturers, so they consisted of GMP and non-GMP manufacturers. (42) Therefore, they could be the representative for the modern drug industry. Due to the similarity in process of modern drug and herbal drug production in this study and the unavailability of the specific criteria of herbal drug industry, the averages of modern drug industry could be applied for the comparison in this study. From the results, it indicated that the herbal production at U-thong Hospital was the labor intensive industry and the ability on using resources for generating profit was equal to the average obtained from private manufacturers.

It was classified as labor intensive industry due to high production labor cost, low performance per employee, and high performance per machinery and equipment value. It meant that the herbal production had labor as major producing factor, whereas the modern drug production used machinery and equipment. Therefore, to compare the indexes about labor and instrument, it should be careful because the criteria that were used to compare should come from the same industry.

Regarding to the ability on generating profit, in overall, it was equal to the average obtained from private manufacturers. When considering in details, it was

found that production cost was higher that indicated by gross profit to sales ratio. This index was the ratios of gross profit (total sales subtracted by production cost) per total sales. Therefore, it should consider to find out the factors affecting the high cost of herbal production. When considering cost structure, material cost was higher that might be occurred from low quality, high purchasing price, or loss in process. For labor cost, it was emphasized to evaluate the performance of staff. For this reason, To control production cost, there are two main approaches, which are to reduce material cost and to increase outputs of the production unit.

This study could roughly reflect to the situation of herbal production of the hospital. Anyway, methodology and results of this study can be used as basic data in the further studies for comparison with herbal production in other hospitals or performance of production unit in the following years.

4. Generalization of the Results

Before using the results, users should consider generalization of the results. The study was performed by using the data of U-thong Hospital where is the 90-bed community hospital. Therefore, this setting might be different from the others on cost structure, production process, and production size. For cost structure, the production unit produced the herbal products to support only pharmacy dispensing unit and Thai traditional medicine center, so the expense of selling activity was not occurred while other organizations especially in private sector included this expense into product cost. For the production process, the production process of the hospital did not reach the Good Manufacturing Practice (GMP) assigned by the Ministry of Public Health.(43) For example:

1) Herbal production area was not separated from modern drug production area.
2) The quality control was not having separated room.
3) The quality control had only two methods. There were thin-layer chromatography for crude herb controlling and weight variation for finished product controlling.

In private sector, some manufacturers met GMP standard, so where GMP standard was reached, the production cost might be increased. Considering in public sector, it is widely accepted that ChaoPhya Abhaibhubejhr Hospital was assigned by the Ministry of Public Health as a model of herbal production in public hospitals.(12) The hospital improved the production process in order to achieve standard finished products. Therefore, the production process of U-thong Hospital was far from those of the ChaoPhya Abhaibhubejhr Hospital, so the comparison between them should be careful. For production size, in the fiscal year 2003, U-thong Hospital produced 76 herbal products, which were valued on selling as 2,422,848.00 baht. At this production size, some instruments were not used at full capacity, so this caused high production cost per unit of all herbal products. If the herbal production was increased and all instruments were used at their full capacity, the production cost per unit of all herbal products would be decreased. Also, the efficiency of herbal production would be increased.

Therefore, the results of this study can be the representative for herbal production in community hospitals due to they were similarity in cost structure, production process, and production size. For the provincial hospitals and private manufacturers, they can apply the methodology of this study to evaluate the efficiency in their organizations.

In addition, for hospital administrators, if the production unit improved production process to reach GMP standard, the production cost might be increased, and the herbal production might not be profitable based on existing prices. Therefore, it is not the end of the decision because the administrators should consider the benefits in broader viewpoint. They were hospital and social benefits. In hospital perspective, the benefits might be savings from substitution of modern drugs and creating good image of the hospital. In social perspective, there were education advantage as a training site for education institutes and generating incomes to community. Although these benefits were not valued in monetary terms and were not included in the study, they should be considered in the decision.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In the fiscal year 2003, the production unit at U-thong Hospital produced 76 herbal products. The data on resource consumption and output production were used to evaluate the efficiency of herbal production by conducting cost-benefit analysis, payback period determination, and productivity evaluation.

Firstly, cost-benefit analysis was conducted. The cost of herbal production was 2,322,521.92 baht and the revenue from sales was 2,422,848.00 baht. So, net benefit was 100,326.08 baht, and benefit to cost ratio was 1.04. It indicated that the herbal production was worthwhile. Secondly, payback period was determined. The payback period was 2 years and 6 months, which were in the acceptable range. It was assumed that the return period of the program investment was rather short. Lastly, productivity was evaluated. It indicated that the herbal production was the labor intensive industry. The ability on using resources for generating profit was equal to the average obtained from private manufacturers. However, there were some points indicating lower productive than the reference e.g. higher production cost indicated by gross profit to sales ratio.

In addition, sensitivity analysis was used to analyze the robustness of the results. It was found that discount rates varied to 0% and 3% in cost-benefit analysis did not change the net benefit to negative value. Conversely, the prices of materials used in production process significantly affected the net benefit. Especially when the prices increased up to 10%, the herbal production was not profitable. It suggested that the raw material purchasing should be well planed and/or product pricing should be revised. For payback period, ±10% variation of number of services implying to production quantity affected only one-month change. Regarding assumption on the

herbal production as a new investment in the fiscal year 2003, the payback period was 6 years and 5 months. It indicated more reality of herbal production investment.

However, before generalizing the results of this study, there were some notes to be concerned as the followings.

1) This production unit did not reach GMP standard.
2) The expense of marketing activity was not occurred at this study site whereas private sector included this expense into product cost.

In conclusion, the results of this study can be used as basic information for hospital administrators to understand the real situation of herbal production and use this information as guidelines to manage resource utilization. In addition, this study can be used as an example to evaluate the efficiency of herbal production in other community hospitals.

Recommendations

Recommendations to U-thong Hospital

1. Materials should be concerned on the quality, purchasing prices, and loss in process because material cost was the major part of herbal production cost.
2. The production unit should consider unprofitable products such as Herbal Compress, Cinnamomum Stomachic, and Guava mouth wash, and then seeks the way to decrease the costs or increase the appropriate prices. In case of costs cannot be decreased or prices cannot be increased, similar quality products of other manufacturers can be considered. Then the production capacity should be used for profitable products such as Appetite Reducing capsule (100 caps.), Lin-Zhi capsule (100 caps.), and Krachai Dum capsule (100 caps.), except for research and development purpose.
3. In this study, some data were estimated because actual data were not available. For instance, time spent of labor and equipment used for each production lot was estimated based on master formula. Therefore, the data system should be designed and then recorded in order to obtain more accurate results.

Recommendations to the policy maker

1. The guidelines of herbal production should be developed and distributed to the hospitals. Also, the production staff should be continually trained.
2. The hospitals where have herbal production should continually evaluate the efficiency of herbal production, so the evaluation guidelines or computer software should be developed.

Recommendations to the further study

1. Due to the production unit associated with Thai traditional medicine center, the Thai traditional medicine center should be evaluated in order to cover the overall results of Thai traditional medicine service.
2. The efficiency on hospital and social perspective should be evaluated in order to cover broader viewpoint.

REFERENCES

1. กรมการแพทย์ กระทรวงสาธารณสุข. สถาบันการแพทย์แผนไทย. กรุงเทพมหานคร: โรงพิมพ์องค์การสงเคราะห์ทหารผ่านศึก; 2537.
2. ศุภสิทธิ์ พรรณารุโณทัย. เศรษฐศาสตร์สาธารณสุขในยุคปฏิรูประบบสาธารณสุข. พิษณุโลก: สุรสีห์กราฟฟิค; 2544.
3. สมพร ภูติยานันต์. ความรู้เบื้องต้นเกี่ยวกับการแพทย์แผนไทย: ว่าด้วยสมุนไพรกับการแพทย์แผนไทย.พิมพ์ครั้งที่ 3. กรุงเทพมหานคร: โรงพิมพ์องค์การสงเคราะห์ทหารผ่านศึก; 2542.
4. สถาบันวิจัยสมุนไพร กรมวิทยาศาสตร์การแพทย์. ประวัติและบทบาทหน้าที่ [Online]. Available from: http://www.dmsc.moph.go.th/webroot/plant/index.asp [Accessed 2004 Feb 26].
5. คณะกรรมการแห่งชาติด้านยา. บัญชียาหลักแห่งชาติ พ.ศ. 2542 (บัญชียาจากสมุนไพร). กรุงเทพมหานคร: ชุมนุมสหกรณ์การเกษตรแห่งประเทศไทย; 2543.
6. คณะกรรมการอำนวยการจัดทำแผนพัฒนาสุขภาพแห่งชาติ ฉบับที่ 9. แผนพัฒนาสุขภาพแห่งชาติ ในช่วงแผนพัฒนาเศรษฐกิจและสังคมแห่งชาติ ฉบับที่ 9 พ.ศ. 2545 - 2549. กรุงเทพมหานคร: โรงพิมพ์องค์การรับส่งสินค้าและพัสดุภัณฑ์; 2544.
7. กรมพัฒนาการแพทย์แผนไทยและการแพทย์ทางเลือก กระทรวงสาธารณสุข. ประวัติการจัดตั้งและนโยบาย [Online]. Available from: http://www.203.157.19.1/dtam/policy.htm [Accessed 2003 Jun 26].
8. กรมพัฒนาการแพทย์แผนไทยและการแพทย์ทางเลือก กระทรวงสาธารณสุข. ข้อมูลการให้บริการการแพทย์แผนไทยของสถานพยาบาลสังกัดกระทรวงสาธารณสุข [Online]. Available from: http://203.157.19.1/dtam/policy01.ppt [Accessed 2003 Jun 26].
9. ภูสิต ประคองสาย, วลัยพร พัชรนฤมล, วิโรจน์ ตั้งเจริญเสถียร. สถานพยาบาลต้องปรับตัวอย่างไรภายใต้นโยบายประกันสุขภาพถ้วนหน้า: กรณีศึกษาจังหวัดจันทบุรี. วารสารวิชาการสาธารณสุข 2544; 10(3): 411-22.
10. กลุ่มงานส่งเสริมภูมิปัญญาการแพทย์แผนไทย สถาบันการแพทย์แผนไทย. 30 บาท รักษาทุกโรคกับการแพทย์แผนไทย [Online]. Available from: http://www.ittm.or.th/supports/support01.htm [Accessed 2003 May 20].
11. สำนักงานปลัดกระทรวงสาธารณสุข. ประกาศคณะกรรมการหลักประกันสุขภาพ เรื่อง การบริการการแพทย์แผนไทย; 2545.

12. Jaroenkitpan N. Cost analysis of herbal products: a case study of Chaophya Abhaibhubejhr Hospital [M.S. Thesis in Pharmacy (Hospital Pharmacy)]. Bangkok: Faculty of Graduate Studies, Mahidol University; 2000.

13. ฝ่ายเภสัชกรรมชุมชน โรงพยาบาลอู่ทอง. สรุปขั้นตอนการผลิตและผลิตภัณฑ์สมุนไพร. สุพรรณบุรี: โรงพยาบาลอู่ทอง; 2545.

14. ฝ่ายเภสัชกรรมชุมชน โรงพยาบาลอู่ทอง. สรุปงานการแพทย์แผนไทย. สุพรรณบุรี: โรงพยาบาลอู่ทอง; 2546.

15. Vogenberg FR. Introduction to applied pharmacoeconomics. New York: McGraw-Hill; 2001.

16. สุกัลยา คงสวัสดิ์. คู่มือการวิเคราะห์ต้นทุนโรงพยาบาลชุมชน. กรุงเทพมหานคร: วิทยาลัยการสาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย; 2538.

17. Drummond MF, O'Brien BJ, Stoddart GL, Torrence GW. Method for the economic evaluation of health care programes.second edition. Oxford: Oxford University Press; 1997.

18. อาทร ริ้วไพบูลย์. การวิเคราะห์ต้นทุนในการดูแลสุขภาพ. กรุงเทพมหานคร: คณะเภสัชศาสตร์ มหาวิทยาลัยมหิดล; 2546.

19. Zerbe RO J, Dively DD. Benefit-cost analysis: in theory and practice. New York: Harper Collins College Publishers; 1994.

20. A National Productivity Institute (NPI) and NEDLAC document. Productivity, economic efficiency and equity [Online]. Available from: http://www.nedlac.org.za/research/occasional/equity.html [Accessed 2004 Jul 15].

21. สถาบันการแพทย์แผนไทย กระทรวงสาธารณสุข. พระราชบัญญัติคุ้มครองและส่งเสริมภูมิปัญญาการแพทย์แผนไทย พ.ศ. 2542. กรุงเทพมหานคร: โรงพิมพ์ ร.ส.พ. 2542.

22. อาทร ริ้วไพบูลย์. รายงานการวิจัย เรื่อง การศึกษามูลค่าการบริโภคผลิตภัณฑ์สมุนไพรผ่านร้านขายยาในประเทศไทย ปี 2546. กรุงเทพมหานคร: สำนักงานคณะกรรมการวิจัยแห่งชาติ; 2546.

23. สมคิด แก้วสนธิ, ภิรมย์ กมลรัตนกุล. เศรษฐศาสตร์สาธารณสุข: การวิเคราะห์และประเมินผลบริการสาธารณสุข.พิมพ์ครั้งที่ 2. กรุงเทพมหานคร: โรงพิมพ์จุฬาลงกรณ์มหาวิทยาลัย; 2536.

24. จิรุตม์ ศรีรัตนบัลล์. ประสิทธิภาพในระบบสุขภาพ. นนทบุรี: โครงการสำนักพิมพ์ สถาบันวิจัยระบบสาธารณสุข; 2543.
25. Creese A, Parker D. Cost analysis in primary health care. Geneva: World Health Organization; 1994.
26. กัญจนา ติษยาธิคม, วลัยพร พัชรนฤมล, วิโรจน์ ตั้งเจริญเสถียร. คู่มือการวิเคราะห์ต้นทุนโรงพยาบาลชุมชน. กรุงเทพมหานคร: สำนักงานพัฒนานโยบายสุขภาพระหว่างประเทศ; 2544.
27. Walker D, Kumaranayake L. Allowing for differential timig in cost analyses: discounting and annualization. Health policy and planning 2000; 17(1): 112-8.
28. Kumaranayake L. The real and the nominal? Making inflationary adjustments to cost and other economic data. Health Policy and Planning 2000; 15(2): 230-4.
29. ชูชีพ พิพัฒน์ศิถี. เศรษฐศาสตร์การวิเคราะห์โครงการ. พิมพ์ครั้งที่ 4. กรุงเทพมหานคร: เท็กซ์แอนด์ เจอร์นัล พับลิเคชั่น; 2544.
30. Sassone PG, Schaffer WA. Cost-benefit analysis: a handbook. New York: Academic Press; 1978.
31. Dewhurst RFJ. Business cost-benefit analysis. London: McGraw-Hill; 1972.
32. วันชัย วิจิรวนิช, สุทัศน์ รัตนเกื้อกังวาน. การวิเคราะห์ต้นทุนอุตสาหกรรมและงบประมาณ. กรุงเทพมหานคร: สำนักพิมพ์แห่งจุฬาลงกรณ์มหาวิทยาลัย; 2540.
33. สถาบันเพิ่มผลผลิตแห่งชาติ. ดัชนีชี้วัดสถานภาพและศักยภาพอุตสาหกรรม [Online]. Available from: http://www.sas.ftpi.or.th/ftpi/ppindex.htm [Accessed 2004 Feb 1].
34. The Bank of Thailand. Consumer price index [Online]. Available from: http://www.bot.or.th/bothomepage/databank/EconData/Econ&Finance [Accessed 2004 Mar 20].
35. The Bank of Thailand. Interest rate [Online]. Available from: http://www.bot.or.th/bothomepage/databank/Financial_Institutions/interestrate/interest_range_t.asp [Accessed 2004 Mar 20].
36. มูลนิธิประเมินค่าทรัพย์สินไทย. การประเมินค่าเช่าที่ดิน [Online]. Available from: http://www.thaiappraisal.org/Thai/Valuation/Valuation23.htm [Accessed 2004 May 10].

37. Business Owner's Toolkit. Financial analysis of major projects [Online]. Available from: http://www.toolkit.cch.com/text/P06_6500.asp [Accessed 2004 Mar 1].

38. ชัยยศ สันติวงษ์. การบริหารการผลิต. กรุงเทพมหานคร: ประชุมช่าง; 2546.

39. Barnes RM. Motion and time study: design and measurement of work. 6th ed. New York: John Wiley & Son; 1968.

40. Niebel BW. Motion and time study. 4th ed. Illinois: Richard D Irwin; 1967.

41. สำนักงานเศรษฐกิจอุตสาหกรรม. ดัชนีการวัดประสิทธิภาพ [Online]. Available from: http://www.oie.go.th/Benchmarking/definition.htm#PI [Accessed 2004 Jul 15].

42. สำนักงานคณะกรรมการอาหารและยา กระทรวงสาธารณสุข. ข้อมูลสถิติด้านยา [Online]. Available from: http://www.fda.moph.go.th/depart/divtec1/med05.html [Accessed 2004 Jul 15].

43. กองวิจัยและพัฒนาสมุนไพร กรมวิทยาศาสตร์การแพทย์. การผลิตยาจากสมุนไพร. กรุงเทพมหานคร: พี.เอ. ลีฟวิ่ง; 2539.

APPENDIX

APPENDIX

See CD inside:

Appendix A Cost calculation of herbal products at U-thong Hospital

I. Labor cost of cost centers at U-thong Hospital
:\Cost calculation\[Direct cost.xls]labor cost

II. Material cost of cost centers at U-thong Hospital
:\Cost calculation\[Direct cost.xls]material cost

III. Capital cost of cost centers at U-thong Hospital
:\Cost calculation\[Direct cost.xls]capital cost

IV. Total direct cost of cost centers at U-thong Hospital
:\Cost calculation\[Direct cost.xls]total direct cost

V. Proportion of cost allocation of transient cost centers at U-thong Hospital
:\Cost calculation\[IDC_Full cost.xls]Allo table

VI. Calculation of full cost of absorbing cost centers
:\Cost calculation\IDC_Full cost.xls

VII. Output of production unit
:\Cost calculation\Output of production unit.xls

VIII. Example of material cost calculation from working formula
:\Cost calaulation\Example of material cost calculation.xls

IX. Calculation of material cost of products
:\Cost calculation\[Micro-costing.xls]material cost

X. Calculation of capital cost of products
:\Cost calculation\[Micro-costing.xls]capital cost

XI. Calculation of labor cost of products
:\Cost calculation\[micro-costig.xls]labor cost

XII. Total cost of products produced in the fiscal year 2003
:\Cost calculation\[Micro-costing.xls]total cost of each product

Appendix B Collecting form of data collection

I. Collecting form of land

:\Collecting_form\[Collecting_form.xls]land

II. Collecting form of building

:\Collecting_form\[Collecting_form.xls]building

III. Collecting form of durable goods

:\Collecting_form\[Collecting_form.xls]durable goods

IV. Collecting form of stocked material

:\Collecting_form\[Collecting_form.xls]stocked material

V. Collecting form of labor cost

:\Collecting_form\[Collecting_form.xls]labor cost

VI. Collecting form of working time proportion

:\Collecting_form\[Collecting_form.xls]working time proportion

VII. Collecting form of material

:\Collecting_form\[Collecting_form.xls]material

VIII. Collecting form of service output

:\Collecting_form\[Collecting_form.xls]output

IX. Collecting form of raw material and packaging material

:\Collecting_form\[Collecting_form.xls]raw & packaging material

X. Collecting form of equipment time spent

:\Collecting_form\[Collecting_form.xls]time spent of equipment

XI. Collecting form of compounding labor cost

:\Collecting_form\[Collecting_form.xls]time spent of labor

XII. Collecting form of resources used in weight variation

:\Collecting_form\[Collecting_form.xls]weight variation

XIII. Collecting form of resources used in TLC

:\Collecting_form\[Collecting_form.xls]TLC

XIV. Collecting form of resources used in prepared herb powder

:\Collecting_form\[Collecting_form.xls]prepared herb powder

BIOGRAPHY

NAME	Ms.Nattaya Pansang
DATE OF BIRTH	29 October 1971
PLACE OF BIRTH	Suphan Buri, Thailand
INSTITUTIONS ATTENDED	Silpakorn University, 1995: Bachelor of Pharmacy Mahidol University, 2004: Master of Science in Pharmacy (Pharmacy Administration)
POSITION&OFFICE	U-thong Hospital, Suphan Buri, Thailand Position: Pharmacist Tel. 0-3555-1422 E-mail: nty012@yahoo.com
HOME ADDRESS	56 M.11 T. Thung Khok A. Song Phi Nong, Suphan Buri 72190 Tel. 0-1657-0874