COST-EFFECTIVENESS ANALYSIS OF PUBLIC-PRIVATE MIXED MODELS IN NATIONAL TUBERCULOSIS PROGRAM IN HO CHI MINH CITY, VIETNAM

Mr. Tran Nhat Quang

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Health Economics and Health Care Management
Faculty of Economics
Chulalongkorn University
Academic Year 2012

การวิเคราะห์ต้นทุนประสิทธิผลของรูปแบบความร่วมมือภาครัฐ-เอกชนในโปรแกรมวัณโรค เมืองโฮจิมินห์ ประเทศเวียดนาม

นายตรัน นัท ควัง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

สาขาวิชาเศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ

คณะเศรษฐศาสตร์จุฬาลงกรณ์มหาวิทยาลัย

ปีการศึกษา 2555

Thesis Title	COST-EFFECTIVENESS ANALYSIS OF PUBLIC-PRIVATE MIXED MODELS IN NATIONAL TUBERCULOSIS PROGRAM IN HO CHI MINH CITY, VIETNAM
By	Mr. Tran Nhat Quang
Field of Study	Health Economics and Healthcare Management
Thesis Advisor	Associate Professor Siripen Supakankunti, Ph.D.
Thesis Co-advisor	Professor Nathorn Chaiyakunapruk, Pharm.D., Ph.D.

Accepted by the Faculty of Economics, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

....Dean of the Faculty of Economics
(Associate Professor Chayodom Sabhasri, Ph.D.)

THESIS COMMITTEE

....Chairman
(Chantal Herberholz, Ph.D.)

....Thesis Advisor
(Associate Professor Siripen Supakankunti, Ph.D.)

....Thesis Co-advisor
(Professor Nathorn Chaiyakunapruk, Pharm.D., Ph.D.)

....External Examiner
(Porntep Siriwanarangsun, M.D., Ph.D.)

ตรัน นัทควัง : การวิเคราะห์ต้นทุนประสิทธิผลของรูปแบบความร่วมมือภาครัฐ-เอกชนในโปรแกรมวัณโรคเมืองโฮจิมินห์ ประเทศเวียดนาม (COST-EFFECTIVENESS ANALYSIS OF PUBLIC-PRIVATE MIXED MODELS IN NATIONAL TUBERCULOSIS PROGRAM IN HO CHI MINH CITY, VIETNAM) อ.ที่ปรึกษา: รศ. ดร.ศิริเพ็ญ ศุภกาญจนกันติ, อ.ที่ปรึกษา: ศ.ดร.ณธร ชัยญาคุณาพฤกษ์, 102 หน้า.

ตามที่องค์การอนามัยโลกได้เสนอแนะทั่วโลกให้ใช้โปรแกรมวัณโรค (TB) แบบผสมผสานภาครัฐ-เอกชน (PPM) เพื่อเพิ่มความร่วมมือระหว่างภาครัฐและเอกชนในการรักษาควบคุมวัณโรคให้เป็นไปอย่างมีประสิทธิภาพ แม้ว่าจะเห็นผลทางคลินิกของ PPM อย่างชัดเจนแต่ยังคงไม่มีความชัดเจนในผลกระทบทางเศรษฐศาสตร์เมื่อเปรียบเทียบระหว่าง PPM กับรูปแบบเดิมซึ่งมีเพียงรัฐบาลที่ให้การรักษาควบคุมวัณโรคตามรูปแบบ DOTS การศึกษาครั้งนี้มีจุดมุ่งหมายในการวัดต้นทุนประสิทธิผลของการรักษาวัณโรคและต้นทุนประสิทธิผลที่เพิ่มขึ้นจากรูปแบบ PPM เทียบกับรูปแบบเดิมในมุมมองของระบบสุขภาพภายใต้โครงการวัณโรคแห่งชาติเวียดนาม (NTP) เมืองโฮจิมินห์ประเทศเวียดนาม การศึกษานี้ใช้วิธีการคิดต้นทุนตามกิจกรรม โดยได้รวมต้นทุนทางการเงินและทางเศรษฐศาสตร์ แต่ไม่ได้รวมต้นทุนของผู้ป่วย และในการวัดประสิทธิผลของโปรแกรมวัณโรคได้เริ่มตั้งแต่อัตราการตรวจพบความสำเร็จของการรักษาและปีชีวิตที่ยืนยาวขึ้นของผู้ป่วยโดยใช้ข้อมูลปี 2554 และดอลลาร์สหรัฐปี 2554

การศึกษาครั้งนี้พบว่า PPM เพิ่มอัตราการตรวจพบเชื้อวัณโรคทุกชนิดอย่างมีนัยสำคัญจาก 22.49% ถึง 41.71%ของผู้ติดเชื้อใหม่จาก 40.52% เป็น 98.41%, ต้นทุนทั้งหมดต่อปีชีวิตที่ยืนยาวลดลงจาก17.75 เหรียญสหรัฐถึง 11.89 เหรียญสหรัฐ อัตราส่วนต้นทุนประสิทธิผลที่เพิ่มขึ้น (ICER) จากการดำเนินการ PPM อยู่ที่ประมาณ 5.4515 เหรียญสหรัฐต่อปีชีวิตที่ยืนยาวขึ้น การวิเคราะห์ความไวทางเดียวและการวิเคราะห์ความไวของความน่าจะเป็นเพื่อเพิ่มความน่าเชื่อถือของผลลัพธ์เหล่านี้ต่อต้นทุนประสิทธิผลที่เพิ่มขึ้น (ICER) ซึ่งพบว่าค่าสามารถเปลี่ยนจาก 0.3 เหรียญสหรัฐ (ที่ร้อยละ 10%) ถึง 15.3 เหรียญสหรัฐ (ที่ร้อยละ 90%) นอกจากนั้นการวิเคราะห์ต้นทุนประสิทธิผลที่ยอมรับได้ แสดงว่าระบบ PPM จะสามารถทำให้ระดับประสิทธิผลได้ถึงระดับ 100% ถ้าความยินดีที่จะจ่ายอย่างต่ำคือ 704 เหรียญสหรัฐ

โปรแกรมวัณโรคในเมืองโฮจิมินห์เป็นต้นทุนที่มีประสิทธิผลเพื่อให้มีประสิทธิผลและเพื่อให้มีประสิทธิผลมากขึ้นจึงได้นำรูปแบบการดำเนินการ PPM มาใช้ โดยที่รูปแบบที่ 1ของ PPM หรือระบบส่งต่อได้รับการพิสูจน์ว่าแข็งแกร่งควรทำให้เกิดความยั่งยืนหรือมีการขยายเพิ่มขึ้นเนื่องจากประสิทธิผลเพิ่มขึ้นอย่างเห็นได้ชัด PPM มีต้นทุนเพิ่มขึ้นขณะเดียวกันก็มีประสิทธิผลมากขึ้นเช่นกัน

สาขาวิชา: เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ	ลายมือชื่อนิสิต ....
ปีการศึกษา: 2555	ลายมือชื่ออ.ที่ปรึกษาวิทยานิพนธ์หลัก....................
	ลายมือชื่ออ.ที่ปรึกษาวิทยานิพนธ์ร่วม.....................

5585594329: MAJOR HEALTH ECONOMICS AND HEALTH CARE MANAGEMENT
KEYWORDS: COST-EFFECTIVENESS ANALYSIS / PUBLIC-PRIVATE MIXED MODELS / NATIONAL TUBERCULOSIS PROGRAM / HO CHI MINH CITY / VIETNAM

TRAN NHAT QUANG: COST-EFFECTIVENESS ANALYSIS OF PUBLIC-PRIVATE MIXED MODELS IN NATIONAL TUBERCULOSIS PROGRAM IN HO CHI MINH CITY, VIETNAM. ADVISOR: ASSOC.PROF. SIRIPEN SUPAKANKUNTI, Ph. D., CO-ADVISOR: PROF. NATHORN CHAIYAKUNAPRUK, Pharm.D., Ph.D., 102 pp.

Public-private mixed system (PPM) in Tuberculosis (TB) program is internationally recommended by WHO to increase cooperation between public and private sector for effectively providing TB treatment. Although clinical benefits of PPM are apparent, the economic impacts of PPM are still unclear compared with the conventional system (previous TB system), in which only public health system provided TB treatments following DOTS. This study aims to measure the cost-effectiveness of TB treatment and incremental cost-effectiveness in the PPM models compared to the previous TB system from a health system perspective under Vietnamese National TB Program (NTP) in Ho Chi Minh City, Vietnam.

Using activity-based costing method, costs were included financial and economic costs, excluded any costs related to patients. Effectiveness of TB program was measure through detection rate, successful treatment, and life-years gained. All data were collected for the year 2011, using USD in 2011.

This study found that PPM was significantly increasing detection rates of all type of TB from 22.49% to 41.71%, of newly infected TB were from 40.52% to 98.41%; reducing total cost per life-year gained from 17.75 USD to 11.89 USD. Incremental cost-effectiveness ratio (ICER) of PPM implemented was around 5.4515 USD per life-year gained. One-way sensitivity analysis and Probabilistic sensitivity analysis proved robustness of these results on ICER which can be variable from 0.3 USD (at 10%) to 15.3 USD (at 90%). Cost effectiveness acceptability analysis showed that the PPM system will meet 100% being cost effective if the willingness to pay is at least 704 USD.

TB program in Ho Chi Minh City was cost effective, and PPM implemented lead to more cost effective. Particularly, the model 1 – "referring model" of PPM, in which TB suspects were screened in contractors, and then referred to the NTP system for detecting and treating, was strongly proven that it should be sustained, or even expanded because of the obvious improved effectiveness. PPM was more cost respecting with more effective.

Field of Study: Health Economics and Health Care Management Student's Signature......................
Academic Year: 2012 Advisor's Signature.....................
Co-advisor's Signature ....

ACKNOWLEDGEMENTS

This thesis would not have been possible without the assistance and support of many individuals. Their efforts are deeply appreciated. I would like to acknowledge the following individuals who deserve special appreciations.

I would like to appreciate Associate Professor Siripen Supakankunti, my thesis principal advisor, for her excellent guidance, amiable advice and support through this work; and Professor Nathorn Chaiyakunapruk, my thesis co-advisor, for his very valuable advices and supports through this work.

I would like to appreciate Chantal Herberholz, Ph.D., chairman of the thesis committee; and Porntep Siriwanarangsun, M.D., member of the committee, for very valuable suggestions and comments on this work.

I would like to appreciate all professors and staffs of Centre for Health Economics and the Faculty of Economics, Chulalongkorn University, for their professional, warm guidance and support during the whole year of graduation and this thesis.

For data collection, I would like to give the honest appreciation to Dr. Nguyen Huy Dung, Ph.D., M.D., the Director of Pham Ngoc Thach hospital in Ho Chi Minh City, Vietnam, for providing favorable conditions supported; Dr. Tran Ngoc Buu, Ph.D., M.D., the General Manager of Vietnamese National Tuberculosis Program in Ho Chi Minh City, for worthy suggestions and comments; as well as all colleagues from the Managing Department of National Tuberculosis Program in Ho Chi Minh City, for data collections,

I kindly appreciate all secondary data sources from Pham Ngoc Thach hospital, 24 District TB Units, 322 Communal Healthcare Centers, and all contractors under Vietnamese National Tuberculosis Program in Ho Chi Minh City.

Specially, I would like to thank Ms. Pham Vu Bich Ngoc, my colleague, who directly supported and helped for my data collection thoroughly.

Finally, I would like to thank my parents, Mr. Tran Thanh Quang and Mrs. Tran Thi Thu Ngan, who were always beside me with essential emotional supports during my study

.

CONTENTS

Page

Abstract in Thai....iv
Abstract in English....v
Acknowledgements....vi
Contents....vii
List of tables....xi
List of figures....xii
List of equations....xii
List of Abbreviations....xiii
CHAPTER I INTRODUCTION....1
1.1. Rationale....1
1.2. Research Question....5
1.2.1. Primary question....5
1.2.2. Secondary questions....5
1.3. Research Objectives....5
1.3.1. General objectives....5
1.3.2. Specific objectives....5
1.4. Scope of Study....6
1.5. Expected Benefits....6
CHAPTER II BACKGROUND....8
2.1. Tuberculosis....8
2.2. Tuberculosis Burden....8
2.2.1. Global perspective....8
2.2.2. In Vietnam....9
2.2.3. In Ho Chi Minh City....12
2.3. Directly Observed Treatment, Short-course (DOTS)....12
2.4. Global Strategies to Prevent and Control TB....12
2.4.1. Global Plan for TB control and Millennium development goal 6....12
2.4.2. Stop TB Partnership targets....13
2.5. Vietnamese National Tuberculosis Program....13
2.5.1. Case definitions....14

Page

2.5.2. TB treatment outcome definition 15
2.5.3. Diagnosing Activities and detecting process 15
2.5.4. Treating Activities 16
2.5.5. Monitoring Activities 19
2.5.6. Training Activities 20
2.5.7. Advocacy – Communication – Social Mobilization activities (ACSM) 20
2.6. Public-Private Mixed Models 20
CHAPTER III LITERATURE REVIEW 26
3.1. Cost-effectiveness Analysis 26
3.2. Costs of Healthcare Program 26
3.2.1. Perspective 27
3.2.2. Time horizon 28
3.2.3. Types of costs 28
3.2.4. Organization identification 29
3.2.5. Activity identification 29
3.2.6. Identification, measurement and valuation of resources used 30
3.2.7. Special cost calculation 30
3.2.8. Costing approaches 30
3.3. Effectiveness of TB Program 32
3.4. Incremental cost-effectiveness analysis 32
3.5. Cost-effectiveness of TB treatments 33
3.5.1. DOTS treatment effects on TB status 33
3.5.2. Smear-positive pulmonary TB treatment 34
3.5.3. Smear-negative and extra-pulmonary TB 34
3.5.4. Directly observe supervisor 35
3.5.5. TB treatments base on different healthcare system levels 35
3.5.6. Drug resistant TB 36
3.5.7. PPM models 38
3.5.8. Summary 39
CHAPTER IV RESEARCHMETHOD 42
4.1. Study Design 42
4.2. Target and Study Populations 42

Page

4.3. Type of Data 42
4.4. Data Collection 43
4.4.1. Patient's data from medical records 43
4.4.2. Ho Chi Minh City Tuberculosis Program's reports 43
4.4.3. Qualitative data from in-depth interviews and direct observations 44
4.5. List of assumptions 44
4.6. Conceptual framework 45
4.7. Costing Method 47
4.7.1. Cost definitions 48
4.7.2. Activity identification and organization identification 48
4.7.1. Cost components 49
4.7.2. Cost of Diagnosing activities 50
4.7.3. Cost of Treating activities 51
4.7.4. Cost of Monitoring activities 52
4.7.5. Cost of Advocacy – Communication – Social Mobilization (ACSM) activities 52
4.7.6. Cost of Training activities 53
4.8. Measuring Effectiveness 53
4.9. Discount, Depreciation, and Inflation Adjustment 53
4.10. Incremental Cost-Effectiveness Analysis 54
4.11. Decision tree model 55
4.12. Sensitivity analysis 56
CHAPTER V RESULT 59
5.1. Characteristics of TB patients in Ho Chi Minh City 59
5.2. Resources used 60
5.3. Activity-based costing 64
5.3.1. Administrative activities 64
5.3.2. Monitoring activities 65
5.3.3. Infection control, ACSM, training, researching activities 66
5.3.4. Screening activities 68
5.3.5. Detecting activities 69
5.3.6. Treating activities 70

Page

5.3.7. Summary 72
5.4. Measuring effectiveness 73
5.4.1. Outcome summary 73
5.4.2. Detection and treatment 74
5.4.3. Dead averted and Life-year saved 76
5.5. Cost-effectiveness analysis 77
5.5.1. Average costs and unit costs per screened suspects, detected TB patients, treated TB patients 77
5.5.2. Cost per life-year saved 78
5.6. Incremental cost-effectiveness analysis 78
5.7. Sensitivity analysis 79
5.7.1. Uncertainty 79
5.7.2. One-way sensitivity analysis and Tornado diagram 79
5.7.3. Probabilistic sensitivity analysis 81
5.7.4. Cost-effectiveness acceptability 82
CHAPTER VI DISCUSSION 84
6.1. Characteristic of TB patients in Ho Chi Minh City in 2011 84
6.2. Costs 84
6.3. Effectiveness 85
6.4. Cost-effectiveness 87
6.5. Incremental cost-effectiveness 87
6.6. Sensitivity analysis 87
6.7. Limitation of study 88
CHAPTER VII CONCLUSION AND RECOMMENDATION 90
7.1. Conclusion 90
7.2. Recommendation 93
References 94
Biography 102

LIST OF TABLES

Page

Table 2.1. The treatment outcome definition applies to AFB+/AFB-/EPTB 15

Table 2.2. Sputum monitoring by smear microscopy in new pulmonary TB patients 19

Table 2.3. Sputum monitoring of pulmonary TB patients receiving the 8-months re-treatment regimen with the first line anti-TB drugs 19

Table 2.4. Summary of number of contractors under each model in PPM in 2011 22

Table 2.5. Summary of the responsibilities of each kind of providers in PPM 23

Table 2.6. Summary of the responsibilities in each modelof PPM 24

Table 3.1. Summary for CER of each type of TB treatment (1) 40

Table 3.2. Summary for CER of each type of TB treatment (2) 40

Table 3.3. Summary for CER of each type of direct observer 41

Table 3.4. Summary for CER of PPM system...41

Table 4.1. Identification of the activities implemented at each level of healthcare system...49

Table 4.2. Consumer Price Index of Vietnam (2005 = 100) 54

Table 5.1. Characteristics of TB patients in Ho Chi Minh City, Vietnam, in 2010 and 2011 (1) 59

Table 5.2. Characteristics of TB patients in Ho Chi Minh City, Vietnam, in 2010 and 2011 (2) 60

Table 5.3. Characteristics of TB patients in Ho Chi Minh City, Vietnam, in 2010 and 2011 (3) 60

Table 5.4. Summary of areas used for TB program 62

Table 5.5. Summary of equipments used for TB program 62

Table 5.6. Summary of human resources used for TB program......................................62

Table 5.7. Summary of materials used for TB program..63

Table 5.8. Allocation criterion capital costs for administrative activities 65

Table 5.9. Allocation criterion capital costs for monitoring activities 66

Table 5.10. Allocation criterion capital costs for IC, ACSM, training, researching activities..67

Table 5.11. Allocation criterion capital costs for screening activities...............................69

Table 5.12. Allocation criterion capital costs for detecting activities 70

Table 5.13. Allocation criterion capital costs for treating activities...................................72

Table 5.14. Summary of Activity cost components in TB program for PPM 72

Page

Table 5.15. Summary of Activity cost components in TB program for the previous TB system 72
Table 5.16. Outcome summary of TB program in Ho Chi Minh City in 2011 74
Table 5.17. Summary of effectiveness of TB program in terms of detection and treatment 75
Table 5.18. Summary of Life-years saved of each kind of outcome 77
Table 5.19. Average cost per each type of outcome (USD in 2011) 78
Table 5.20. Unit cost of each activity (USD in 2011) 78
Table 5.21. Summary of the characteristics of parameters cause uncertainties 79
Table 5.22. Summary of ICER changing respected with the changes of each parameter from -20% to +20% of its origin 81
Table 5.23. Statistical summary of ICER in Probabilistic sensitivity analysis 82
Table 5.24. Probability of being cost-effective respected with the willingness to pay 82

LIST OF FIGURES

Page

Figure 2.1. TB profiles of Vietnam 10
Figure 2.2. TB finance profiles of Vietnam 11
Figure 2.3. Diagnosing and detecting process 16
Figure 2.4. Framework of Public-Private Mixed Models 21
Figure 4.1. Conceptual framework of study 47
Figure 4.2. Decision tree model 58
Figure 5.1. Tornado diagram for One-way sensitivity analysis of ICER when each parameter changed from -20% to +20% of its origin 80
Figure 5.2. Scatter Plots for Probabilistic sensitivity analysis 81
Figure 5.3. Cost-effectiveness acceptability curve 82

LIST OF EQUATIONS

Page

Equation 4.1. Formula for calculating the inflation adjusted cost using CPI 54
Equation 4.2. Formula of Incremental Cost-Effectiveness Ratio 55

LIST OF ABBREVIATIONS

ACSM	:	Advocacy, Communication, and Social Mobilization
AFB	:	Acid fast bacilli
AIDS	:	Acquired immunodeficiency syndrome
CEAC	:	Cost-effectiveness acceptability curve
CHC	:	Communal Health Center
Cm	:	Capreomycine
CN¥	:	Chinese Yuan Renminbi
Cs	:	Cycloserin
CXR	:	Chest X-ray
DALY	:	Disability-Adverted Life Year
DOT	:	Directly observed treatment
DOTS	:	Directly observed treatment, short course
DPMC	:	District Preventive Medicine Center
E	:	Ethambutol
EPTB	:	Extra pulmonary tuberculosis
H	:	Isoniazid
HBCs	:	High TB-Burden Countries
HIV	:	Human immunodeficiency virus
HRQL	:	Health-Related Quality-of-Life
IC	:	Infection control
Km	:	Kanamycin
Lfx	:	Levofloxacin
MDR-TB	:	Multidrug-resistant TB (resistance to at least R and H)
MoH	:	Ministry of Health
NGO	:	Non-governmental organization
NTP	:	Vietnamese National Tuberculosis Program
PAL	:	Practical approach to lung health
PCR	:	Polymerase chain reaction
PHC	:	Primary health care
PI	:	Protease inhibitor

PNT	:	Pham Ngoc Thach hospital - Tuberculosis and Lung Disease Specific Hospital
PPM	:	Public-Private mixed system
PSA	:	Probability sensitivity analysis
PTB	:	Pulmonary tuberculosis
Pto	:	Prothionamide
QALE	:	Quality-Adjusted Life Expectancy
QALY	:	Quality-Adjusted Life Year
R	:	Rifampicin
S	:	Streptomycin
SA	:	Sensitivity analysis
sm-	:	smear-negative
sm+	:	smear-positive
T	:	Thioacetazone
TB	:	Tuberculosis
TB/HIV	:	HIV-related TB
THB	:	Thailand Bath
TMP	:	Trimethoprim
UNAIDS	:	Joint United Nations Programme on HIV/AIDS
US$	:	United States Dollar
USAID	:	United States Agency for International Development
WHO	:	World Health Organization
XDR-TB	:	Extensively drug-resistant TB
YLD	:	Year of Life Disabled
YLL	:	Year of Life Lost
Z	:	Pyrazinamide

CHAPTER I
INTRODUCTION

1.1. Rationale

Tuberculosis (TB) is still significantly a very dangerous disease, a major public health problem throughout the world. Nowadays, even though there is DOTS (Directly observed treatment, short course) as an internationally recommended strategy for TB control, TB burden still has major effects on the society and the economy. Tuberculosis impacted negatively on socioeconomic prosperity globally (Ray, Sharma, Singh, & Ingle, 2005). Tuberculosis is a severe burden not only for TB patients but also on the healthcare system nationally, especially in developing countries. TB is classified as social diseases group because the impacts on lower socioeconomic group are much higher than on higher socioeconomic groups (Peabody, Shimkhada, Tan, & Luck, 2005). Despite of the attempts of the National Tuberculosis Program (NTP), the TB situation in Vietnam is still severe. According to the a report of WHO (World Health Organization) in 2008, Vietnam was ranked 13th of top 22 countries that suffering from the most severe burden of TB over the world (WHO, 2008).

Healthcare provision in the Vietnam health system is divided into two main sectors, public and private sectors. In the previous TB system, in which healthcare provision based mostly on the public sector, public sector and the private sector were running and independently from each other. Under NTP, some surveys found out that the proportion of people who sought care at private healthcare facilities was high. Up to 37% of TB suspects, who had respiratory symptoms, visited private healthcare facilities for the first time, and for a coming diagnostic check up to thirty weeks (NTP, 2007). People who seek medical care from these providers were at risk of receiving inappropriate TB care and treatment, which could lead to the development of drug-resistance. There are around one-fourth of observed private healthcare facilities providing TB treatment, of which many treated TB incorrectly from the national TB treatment guidelines (NTP, 2011). It is recommended to develop a model linking functions of public and private sectors and thus enhance their capability. As a matter of fact, under NTP, the Public-Private mixed (PPM) models has been implemented since 2008, and since 2009 in Ho Chi Minh City (Dang, 2012) to provide effective TB treatments. The PPM system is a substitute for the previous TB system, in which TB treatments are provided by the public health care system only.

PPM is an internationally recommended Stop TB strategy to increase cooperation between public and private sector. It contains four models: Model 1 (Referring suspects), Model 2 (Diagnosing), Model 3 (Treating), and Model 4 (Diagnosing and treating). Basing on their capabilities, the private or public health facilities, which was not belonging to the NTP system, can contract under any model that they can provide appropriate services. In model 1, TB suspects with respiratory symptoms, who seek medical care in the contractors, were screened by symptoms before being referred to public health systems for detection and treatments. TB patients, who seek medical care in the contractors under model 2, would be screened and detected before being referred to public health systems for treatments. If TB suspects seek medical care in contractors under the model 3, they will be referred to public health systems for detection and then, TB treatments will be provided by the private healthcare facilities. TB patients can be referred from public health systems to the contractors for treatments due to efficient TB management. Under the model 4, a comprehensive process for TB detection and treatment can be provided by the contractors only. In PPM under NTP, TB treatments are following DOTS strategies strictly. The private healthcare system has been oriented to develop by the Communist Party and Vietnamese government. The Government has set up legal framework, and has been ready to collaborate with the private sector. The coordination through the Association of Private Medical Practice will bring many advantages and seems to be the most effective model for contracting at present.

The NTP report obviously proved that “PPM system”, which is using standing for the combination of all four models of PPM, really affected the healthcare system. The most importance made PPM being essential is the increasing clinical benefits. Thus, PPM system did really increase the detection rate of TB suspects. In terms of the effectiveness of PPM system, in the year 2010, private sectors contributed 10% of detecting newly smear-positive TB patients, and increased 22% of the screening rate (Dang, 2011).

Although clinical benefits of PPM system are apparent, the economic impacts and the cost-effectiveness are still unclear compared with the previous system in TB program, in which only public sector provided TB treatments following DOTS. Whether PPM models were implemented or not, TB treatments under NTP are always free. In order to reimburse private health facilities for TB treatments, contractors in PPM system would receive financial incentives from the government and the NTP, depending on which model they contracted. In addition, adding an intervention with up-scaled TB program involving private sectors, PPM system certainly costs much more than the previous TB system, and the budget subsidized for this intervention is clearly higher than the previous one. However, the correspondence of the additional costs respected with the additional effectiveness of this intervention has to be evaluated to find out whether whole PPM system is really significantly increase the outcomes with low additional costs respectively. There has been so far no economic evaluation, such as cost-effectiveness, cost-benefits, or cost-utility, done in Vietnam, especially in Ho Chi Minh City.

Besides, from a private sector perspective, due to lacking economic evidence, private sector still plays a giant role in the PPM system leaving the high burden to the public sector in TB treatments (NTP, 2007). Even though the contractors get dispensations for their contributions, they are still afraid of running into catastrophe if they provide free TB treatments. The root cause is because they could not anticipate the cost for TB patient, especially in re-treatment after failure or drug resistance cases, in which the treatment has to be extended for long time. That’s why they were willing to contract under the simplest model for referring TB suspects only, instead of the other advance models for detecting or treating TB patients, or both.

On the other hand, from the perspective of the government and policy maker, the remaining considerable issues are the sustainability of PPM, as well as the decision that which model of PPM should be encouraged. Still be supported by global funds and other grants, especially from PATH (Program for Appropriate Technology in Health – a non-governmental organization from the USA), NTP has encouraged private sectors to do contracting as much as possible, no matter what model of PPM should be encouraged. In the statistical report of TB program in Ho Chi Minh City in 2011, there were three districts supported by PATH specifying for PPM implementation of the TB program. The number of newly detecting cases reported by two of these three districts is significantly higher than most of unsupported districts. However, another supported district reported outcomes indifferently compared with the unsupported districts (NTP, 2011). Apparently, PPM system is very effective. Even though it was financially supported to cover costs, the impacts of financial support are still unclear. Therefore, the increasing cost might not lead to the increasing effectiveness respectively, and the cost-effectiveness is still controversial in PPM system implementation. Furthermore, even if there are real positive financial impacts on the effectiveness of the PPM models, in terms of sustainability in economic development, when global funds and grants withdrawn, NTP will face so many problems because of disability for sustaining PPM models due to incurring high costs without enough support.

Due to the limitation of resources, cost-effectiveness analysis can be the most appropriate solution contributing to the decision-making process. Cost-effectiveness analysis is one of the basic useful tools among economic evaluation methods for evaluating and assessing the effectiveness of healthcare program or health intervention (Drummond, Stoddart, & Torrance, 2005). It is essential for healthcare decision maker in TB programs. From a health system perspective, cost-effectiveness analysis is necessary to consider how much cost per TB treatment the private clinics and the public health system incur, in which level of cost and outcomes they can cover, and whether they should continue contracting. Especially for PPM models under NTP, cost-effectiveness analysis can specify in comparing PPM system with the previous TB system, as well as to compare the four PPM models of with each other.

There has been very few, or even no, research on cost-effectiveness of TB treatments specifying for NTP in Ho Chi Minh City before. As a matter of facts, this research is essential to provide a specific economic evaluation of PPM system compared with the previous TB system, and may become a basis on which more advanced research studies can be conducted, such as cost-utility, cost-benefit, etc. of NTP.

1.2. Research Question

1.2.1. Primary question

What is the cost-effectiveness of TB treatments in the PPM system compared with the previous TB system, from the health system perspective under NTP in Ho Chi Minh City, Vietnam? What is the incremental cost-effectiveness of the PPM system implemented?

1.2.2. Secondary questions

What are the costs and effectiveness of TB treatments in comparison between the PPM system and the previous TB system, from the health system perspective under NTP in Ho Chi Minh City, Vietnam?

What is incremental cost and incremental effectiveness of the PPM system implemented from a health system perspective under NTP in Ho Chi Minh City, Vietnam?

1.3. Research Objectives

1.3.1. General objectives

To measure cost-effectiveness of TB treatment in the PPM system compared to the previous TB system from a health system perspective under NTP in Ho Chi Minh City, Vietnam.

1.3.2. Specific objectives

- To identify, measure, and valuate the cost of TB treatments in the PPM system, the conventional system, and incremental cost of the PPM system implemented through separating activities in NTP.
- To quantify effectiveness of TB treatments through the number of screened suspects, detected TB patients, treated TB patients, successful treatments, and the total life years gained because of death averted in the PPM system, the previous TB system, and incremental effectiveness of the PPM system implemented under NTP.
- To determine the cost-effectiveness of TB treatment in the PPM system compared with the previous TB system under NTP.

- To measure the incremental cost-effectiveness of the PPM system implemented.

1.4. Scope of Study

Cost-effectiveness analysis for TB treatments of the whole tuberculosis program in Ho Chi Minh City pays attention to all activities concerned with TB treatments. This study is conducted in Ho Chi Minh City, Vietnam, including all TB treatment systems on the provincial level and its sub-systems. These are one provincial specific hospital for Tuberculosis and Lung Diseases, Pham Ngoc Thach Hospital (PNT), 24 district TB units allocated ones for every district preventive medical center at district level (DTBU), and all 322 communal health centers (CHC), which are involved in NTP at the communal level. Besides, some information is collected from the contractors cooperated under NTP. All information and data are collected for the fiscal year 2011.

1.5. Expected Benefits

The potential beneficiaries of this study may include Ministry of Health, National Tuberculosis Program, Department of Health in Ho Chi Minh City, scholars involved in health policy, health program management and health economic research. This study allows us to understand the cost effectiveness of TB program at provincial levels as well as incremental cost-effectiveness of public-private mixed models implemented in Vietnam. It reveals the unit costs of each form of TB treatment, the particular cost of each activity in TB program, and the costs of each public-private mixed model.

The result of this study is useful for:

- The policy makers in the health sector, specifically for Ho Chi Minh City, use this information to help in budget planning. The policy makers can allocate resources or make some policy to cover the costs of the health service provision. Furthermore, this study provides an overview of cost-effectiveness of TB program for sustaining PPM system when external funding is no longer available.

- For public health sector, this study result can be used as the evidence for the development of a national standardized activity framework, which should be adjusted for other provinces.
- For private health sectors, this study result can be considered as a transparent evidence for encouraging the private healthcare facilities to expand their roles, contract in the most cost-effective model respecting with their capabilities.

CHAPTER II
BACKGROUND

2.1. Tuberculosis

According to the WHO's Guidelines, Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis* (MTB), which is a rod-shaped bacillus called "acid-fast" (AFB) due to its characteristics in laboratory (WHO, 2010). This kind of Mycobacterium mostly is spread out through the air, then enter the body by breathing, and may infect not only on lung, but also on the other parts via blood stream, the lymphatic system, or by direct extension to other organs. Tuberculosis is normally classified by the availability of MTB in sputum detected from sputum smear microscopy. There are Pulmonary TB (PTB), including both smear-negative (AFB-) and smear-positive cases (AFB+), and the extra-pulmonary TB (EPTB).

TB is most commonly transmitted by inhalation. The people who are living in the same household, or frequently communicate face to face with a TB patient, have a higher risk of TB infection. TB infected people can be in all ages and both sexes. However, there are some groups, which are more vulnerable to develop the disease. Poverty, malnutrition and over-crowded living conditions have been known as the risk of developing TB. HIV (Human immunodeficiency virus) infection has been identified as a major risk factor for developing tuberculosis also. The age group mainly affected by TB is from fifteen to fifty-four years. Consequently, TB is seen as a social disease due to leave a high socio-economic burden in high TB prevalence countries (WHO, 2011).

2.2. Tuberculosis Burden

2.2.1. Global perspective

According to WHO's Global Report 2012, one-third of the world's population is estimated to be infected with tubercle bacilli and hence at risk of developing active disease. Globally, in 2011, the annual incidence of TB, reflected the number of new TB cases, was about almost 9 million people, and the annual number of deaths caused by TB was 1.4 million, including 430 thousand TB-related HIV among 990 thousand HIV patients. The highest burden regions are Asia and Africa. 40% TB cases on over the world are centralized in India and China. MDR-TB are estimated around 3.7% of new cases and 20% of previously treated cases (WHO, 2012a).

The twenty-two High Burden Countries (HBCs) approximately contributed 80% of the estimated number of new TB cases in all forms yearly. These countries are focusing of intensified efforts in DOTS expansion. The HBCs are not necessarily those with the highest incidence rates per capita; many of the latter are medium-sized African countries with high rates of TB/HIV co-infection.

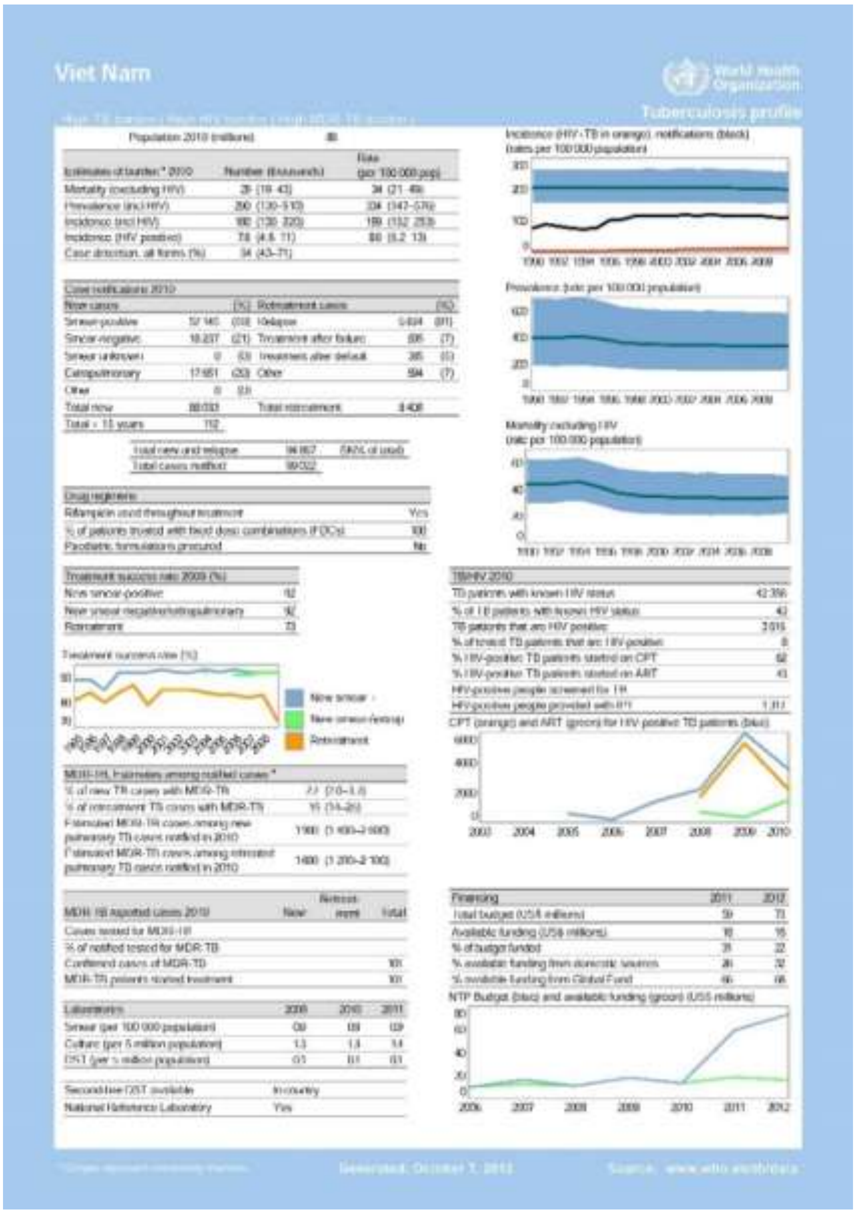
Recent evidences tend to demonstrate that TB prevalence and TB death rates are globally decreasing after having reached a peak. Since 2005, the TB incidence rate has been in decline in all six WHO regions. However, the TB caseload continues to grow in Africa, and Eastern Europe.

2.2.2. In Vietnam

Tuberculosis burden in Vietnam was ranked higher-middle of the Western Pacific Region of which the prevalence is at the middle levels on over the world. According WHO Report in 2012, Vietnam is still a high TB burden as well as HIV and MDR-TB burden (WHO, 2012b). New AFB+ cases estimate of more than 52,145 (95%) and new AFB- cases estimate by 18,237 (21%) for the year 2010. In 2007, WHO estimated that Vietnam ranked twelfth of 22 HBCs, with a prevalence of AFB+ TB of 89 per hundred thousand people population. Despite of the huge efforts of the NTP's network, the TB situation in Vietnam is still quite severe. According to the WHO's report in 2008, Vietnam was ranked 13^{th} of top 22 countries have the highest TB burden on over the world (WHO, 2008). The burden of TB in Vietnam is illustrated in the Figure 2.1 below.

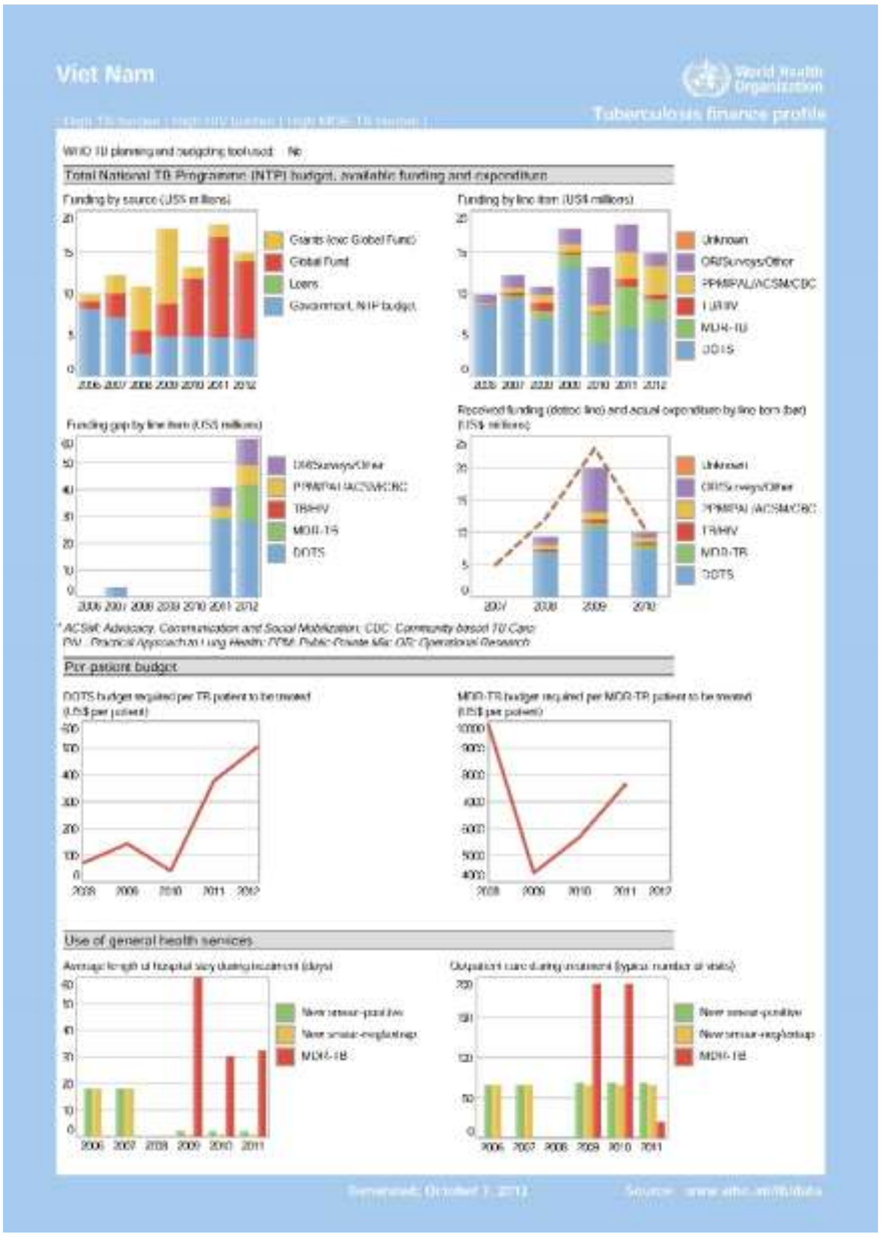
As the goals, the NTP tries to ensure providing high quality TB treatments and making incentives for people accessing these services easily. To achieve these goals, NTP's network effort to increase DOTS cases early detection rate and treatment success. However, NTP in Vietnam is facing many challenges as TB/HIV, MDR-TB, XDR-TB, shortage in human resources, difficulty in managing TB drugs in the market, problems in TB diagnosis and treatment in private area. Thus, there are some studies reported that TB situation in Vietnam will be much more serious due to the variety of many dangerous MTB strains cause severe drug resistances (Buu et al., 2012; V. A. Nguyen et al., 2012; Tram et al., 2012). Besides, a current detecting procedure under NTP in Vietnam is facing many problems that using symptom screening may miss up to 54% AFB- PTB cases in the HIV-infected population because of poorly specific diagnostic performance (Dang, 2012; D. T. Nguyen et al., 2012).

Figure 2.1. TB profiles of Vietnam



(Source: TB profile of Vietnam from WHO (WHO, 2012b))

Figure 2.2. TB finance profiles of Vietnam



(Source: TB profile of Vietnam from WHO (WHO, 2012b))

Due to free services, the costs of TB treatment from a health system perspective are very high and incur a large economic burden. In 2012, budget funded for this program, which is illustrated by the Figure 2.2 above, came from Grants and Global Funds were approximate two times in comparison with the budget came from Government and from NTP itself (WHO, 2012b). This will be a very big challenge in the economic development of Vietnam, when external funds should play a lower role than internal budgets, and self-financed-supporting have to play the main role.

2.2.3. In Ho Chi Minh City

Ho Chi Minh City is an economic central in the Southern of Vietnam with 7,521,100 average populations and 3,589 people per km^2 (GSO, 2011). Due to the highest average population and population density, the risk of TB infection and difficulty in TB controlling seem to be a big problem faced by the healthcare system, especially in NTP. Thus, though the report of NTP at the end of fiscal year 2011 in Ho Chi Minh City, there were 16,870 TB cases all forms, 0.2242% of the population (NTP, 2011). Overall, TB is burdened not only of socio-economic, but also of the healthcare system of Ho Chi Minh City. In Ho Chi Minh City, under NTP, every TB patient will be receiving free treatment (excluding hospitalization and other drugs out of NTP's list) (NTP, 2009).

2.3. Directly Observed Treatment, Short-course (DOTS)

In 1994, DOTS Strategy has been recommended internationally by WHO for TB control programs. The DOTS strategy ensures that infectious TB patients are identified and cured using a standardized drug combination. There are five key components of the DOTS Strategy mentioned in TB management, detection, treatment, drugs, laboratory supplies, recording and reporting systems. The most important component builds up the branch of "DOTS" is the supervision of health workers to patients taking a dose, so that the health workers can ensure, notice, and monitor patients' treatments. Globally, DOTS has been expanded and implemented subsequently in many countries, and reached many achievements.

2.4. Global Strategies to Prevent and Control TB

2.4.1. Global Plan for TB control and Millennium development goal 6

- **Target 8**: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases (UN, 2012).
- **Indicator 23**: Prevalence and death rates associated with tuberculosis.
- **Indicator 24**: Proportion of tuberculosis cases detected and cured under DOTS (the internationally recommended tuberculosis control strategy).

2.4.2. Stop TB Partnership targets

- **By 2005**: At least 70% of people with infectious tuberculosis will be diagnosed (that is, under the DOTS strategy), and at least 85% cured.
- **By 2015**: The global burden of tuberculosis (prevalence and death rates) will be reduced by half compared with 1990 levels. This means reducing the prevalence to less than or equal to 150 per hundred thousand population and deaths less than or equal to fifteenth per hundred thousand population per year by 2015 (including cases co-infected with HIV). The number of people dying from tuberculosis in 2015 should be less than a million, including those co-infected with HIV.
- **By 2050**: The global incidence of tuberculosis disease will be less than one case per million population per year (the criterion for tuberculosis "elimination" adopted in the United States)

2.5. Vietnamese National Tuberculosis Program

The Vietnam National Tuberculosis Control Program (NTP) is based on the principles of DOTS, the core control strategy recommended by WHO. According to WHO estimates, since 1997, Vietnam has reached and exceeded the global targets for tuberculosis control, i.e. to detect more than 70% of new smear-positive pulmonary tuberculosis cases and cure more than 85% of these detected cases. If these targets were met, tuberculosis incidence in Vietnam would predictably decrease over the period 1997–2004 by 44%. Although there was indeed a small decrease in TB notification rates among women and persons older than thirty-five years, this was offset by an increase among young men, which led to stabilization in notification rates during this period.

Besides, the MDR treatment have just involved in TB program since 2009 for officially providing free treatment for MDR patients in Ho Chi Minh City. However, the outcomes of MDR treatment would have comprehensively reported after two years from the date when the patients registered due to long treatment duration. Up now, the MDR patients registered in 2011 have not treated enough time for assessing their treatment outcomes. This study would exclude costs and outcomes of MDR TB patients' treatment. It is one limitation of this study.

2.5.1. Case definitions

According to the guidelines for TB treatment of WHO and NTP in Vietnam (NTP, 2009; WHO, 2010), the TB case definitions below are based on the level of certainty of the diagnosis and on whether or not laboratory confirmation is available.

- **TB suspect:** Any person who presents with symptoms or signs suggestive of TB. The most common symptom of pulmonary TB is a productive cough for more than two weeks, which may be accompanied by other respiratory symptoms (shortness of breath, chest pains, haemoptysis) and/or constitutional symptoms (loss of appetite, weight loss, fever, night sweats, and fatigue).
- **Case of TB:** A definite case of TB (defined below) or one in which a health worker (clinician or other medical practitioner) has diagnosed TB and has decided to treat the patient with a full course of TB treatment. Any person given treatment for TB should be recorded as a case. Incomplete "trial" TB treatment should not be given as a method for diagnosis.
- **A definite case of TB:** A patient with Mycobacterium tuberculosis complex identified from a clinical specimen, either by culture or by a newer method such as a molecular line probe assay. In countries that lack the laboratory capacity to routinely identify M. Tuberculosis, a pulmonary case with one or more initial sputum smear examinations positive for acid-fast bacilli (AFB) is also considered to be a "definite" case, provided that there is a functional external quality assurance (EQA) system with blind re-checking.

Cases of TB are also classified according to the anatomical site of disease (**PTB** and **EPTB**), bacteriological results (including drug resistance) (**AFB+** and **AFB-**), history of previous treatment (**new cases** and **previously treated cases**), HIV status of the patient (**TB/HIV**).

2.5.2. TB treatment outcome definition

TB treatment outcomes are defined clearly by WHO guidelines as well as NTP guidelines in Vietnam, illustrated by Table 2.1 below (NTP, 2009; WHO, 2010).

Table 2.1. The treatment outcome definition applies to AFB+/AFB-/EPTB

Outcome	Definition
Cure (Turn to smear-negative)	A patient whose sputum smear or culture was positive at the beginning of the treatment but who was smear- or culture-negative in the last month of treatment and on at least one previous occasion.
Treatment completed	A patient who completed treatment but who does not have a negative sputum smear or culture result in the last month of treatment and on at least one previous occasion [a]
Treatment failure	A patient whose sputum smear or culture is positive at 5 months or later during treatment. Also included in this definition is patients found to harbor a multidrug-resistant (MDR) strain at any point of time during the treatment, whether they are smear-negative or -positive.
Died	A patient who dies for any reason during the course of treatment.
Default	A patient whose treatment was interrupted for 2 consecutive months or more.
Transfer out	A patient who has been transferred to another recording and reporting unit and whose treatment outcome is unknown.
Treatment success	A sum of cured and completed treatment [b]

[a]: The sputum examination may not have been done or the results may not be available.

[b]: For AFB- or culture- patients only.

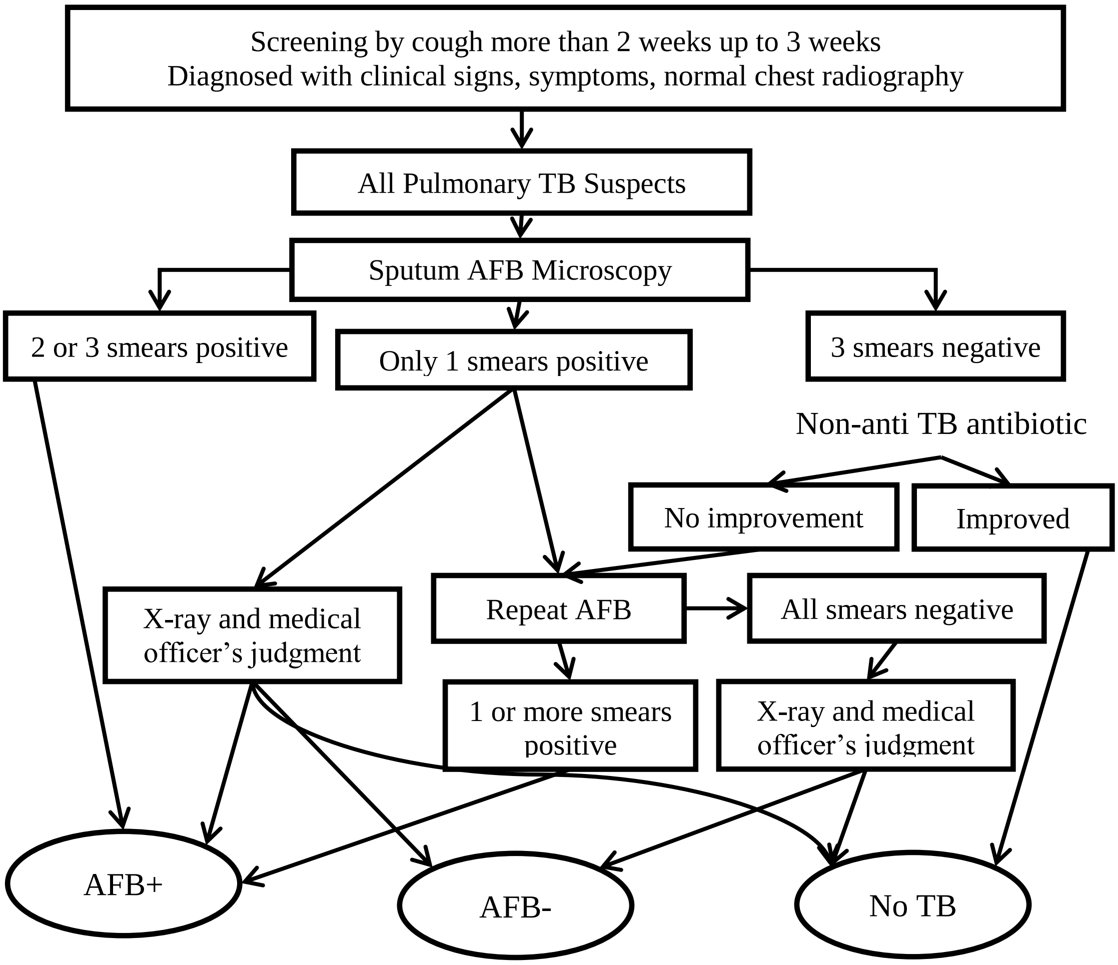
(Source: Guidelines for TB treatment of WHO (WHO, 2010) and NTP (NTP, 2009))

2.5.3. Diagnosing Activities and detecting process

The Figure 2.3 below illustrate for the diagnosing process in TB program in Vietnam. NTP detects cases via three diagnostic algorithms: symptom screening, sputum smear, chest radiography. The sputum screening of suspects with cough attending health facilities (1), as well as screening of contacts (2) and screening of persons living with HIV/AIDS (3). Following the guideline of NTP in Vietnam, suspected PTB are screened through common symptoms: Cough more than two weeks up to three weeks, losing weight, tired, slight fever (especially in the afternoon). There are some high-risk groups should be considered in diagnosing: HIV/AIDS people, people who contacts with AFB+ TB patients, drug addiction, severe smoker, people who use corticoid or cancer treatment drugs for a long time, etc. (NTP, 2009; WHO, 2010, 2011).

Under NTP, the common method of diagnosis new Pulmonary TB is a sputum AFB test by observing the directly sputum specimen using microscopy, chest X-Ray, and medical officer's judgment.

Figure 2.3. Diagnosing and detecting process



(Source: Guidelines for TB treatment of WHO (WHO, 2010) and NTP (NTP, 2009))

2.5.4. Treating Activities

The aims of treatment of tuberculosis are:

- To cure the patient and restore quality of life and productivity;
- To prevent death from active TB or its late effects;

- To prevent relapse of TB;
- To reduce transmission of TB to others;
- To prevent the development and transmission of drug resistance.

There are five types of essential anti-tuberculosis drugs (first line) using in Vietnam: Isoniazid (H), Rifampicin (R), Pyrazinamid (Z), Streptomycin (S) and Ethambutol (E). There are three main regimens using in TB treatment in Vietnam under NTP (NTP, 2009):

- ***Regimen 1:*** **2S (E) HRZ/6HE** or **2S (E) RHZ/4RH**
  - TB patients are treated in two phases: intensive phase for two months (with H, R, Z, and S or E used daily. S can be substituted by E), then continuation phase for four months (with R and H used daily) or for six months (with H and E used daily)
  - This regimen is applied for new TB patients, who have never treated TB before or previously treated TB less than 1 month. In Vietnam, we are using 6HE for the continuation phase
- ***Regimen 2:*** **2SHRZE/1HRZE/5$H_3R_3E_3$**
  - TB patients are treated in two phases: intensive phase for three months (the first two months with S, H, R, Z, and E used daily, and the third month with H, R, Z, and E used daily), then continuation phase for five months (with H, R and E used three times weekly).
  - This regimen is applied for TB patients who are relapsed or failure after treating by regimen 1. This regimen is also applied to TB patients who retreated after defaulted, drug resistant TB suspects, as well as some severe TB and the other form of TB patients.
- ***Regimen 3:*** **2HRZE/4HR** or **2HRZ/4HR**
  - TB patients are treated in two phases: intensive phase for two months (with H, R, Z, and E, or without E, used daily), then continuation phase for four months (with R and H used daily).
  - This regimen applies to all children TB patients, pregnant women or women who are breastfeeding. In some severe children TB cases, S is considerable to be used. S should never be used for

pregnant women or women who are breastfeeding because S can because of their babies' deafness.

For TB re-treatment, chronic TB or drug resistant TB treatment, we are mainly using two extended regimens (4a and 4b) with the second line anti-tuberculosis drugs, including Capreomycine (Cm), Levofloxacin (Lfx), Prothionamide (Pto), Cycloserin (Cs), Kanamycin (Km). These regimens are only allowed to apply in health facilities have enough capacities for MDR-TB treatments (NTP, 2009).

- ***Regimen 4a*****: 6Z.E.Km.Lfx.Pto.Cs/12Z.E.Lfx.Pto.Cs**
  - TB patients are treated in two phases: intensive phase for six months (with Z, E, Km, Lfx, Pto, Cs, used daily), then continuation phase for twelve months (without Km, used daily).
  - This regimen applies to the failure treated patients after regimen 1 and regimen 2, or drug resistant TB (with antibiotic test).
- ***Regimen 4b*****: 6Z.E.Cm(Km).Lfx.Pto.Cs/12Z.E.Lfx.Pto.Cs**
  - TB patients are treated in two phases: intensive phase for six months (with Z, E, Lfx, Pto, Cs, Cm or Km, used daily), then continuation phase for twelve months (without Cm or Km, used daily).
  - This regimen is applied to the chronic TB patients, or drug resistant TB (with antibiotic test).

The daily dosage is standardized for three or four body weight bands – for instance 30–39kg, 40–54kg, 55–70kg and over 70kg, as is done with the Global Drug Facility patient kits. Other special cases, which have other diseases together with TB, need to be judged by specialist for considering which regimen should be applied, and how long the treatments should be taken. In TB/HIV cases, most of the cases can apply the similar regimen with non-HIV TB patients. However, anti-TB drugs should be used together with Cotrimoxazol and ARV (following the TB/HIV treatment guideline) for avoiding opportunistic infections, and these cases need to be judged by a specialist.

Drug-resistant cases are treated much more complicated. Due to lack the second-line drugs for these cases under NTP, there are only a few provinces providing drug resistant TB free, including Ho Chi Minh City. In Ho Chi Minh City, MDR-TB patients receive free treatments, excluding hospitalization.

Pulmonary TB patients are treated in the community, directly observed by CHCs (or district hospitals in intensive phase, depend on the patients' needs and their situation) in their localities. MDR-TB patients are treated in hospital at least two weeks initially. After, they will be treated in the community depending on their situation, and basing on doctor's judgments (NTP, 2009). During treatment, new pulmonary TB patients and the pulmonary TB patient receiving the 8-month re-treatment regimen with the first line anti-TB drug will be monitored by smear microscopy illustrated by the Table 2.2 and the Table 2.3 below, respectively (WHO, 2010).

Table 2.2. Sputum monitoring by smear microscopy in new pulmonary TB patients

Months of treatment					
1	**2**	**3**	**4**	**5**	**6**
	•			•[a] If sm+, obtain a culture, DST[b]	•[a] If sm+, obtain a culture, DST[b]
If smear-positive at month 2, obtain sputum again at month 3. If smear-positive at month 3, obtain a culture and DST					
	• (sm+)	• If sm+, obtain a culture, DST**		• If sm+, obtain a culture, DST[b]	• If sm+, obtain a culture, DST[b]

• : Sputum smear examination
sm+ : Smear-positive
a : Omit if the patient was smear-negative at the start of treatment and at 2 months
b : Smear- or culture-positivity at the fifth month or later (or detection of MDR-TB at any point) is defined as treatment failure and necessitates re-registration and change of treatment

(Source: Guidelines for TB treatment of WHO (WHO, 2010) and NTP (NTP, 2009))

Table 2.3. Sputum monitoring of pulmonary TB patients receiving the 8-months re-treatment regimen with the first line anti-TB drugs

Months of treatment							
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		• If sm+, obtain culture, DST		• If sm+, obtain culture, DST[a]			• If sm +, obtain culture, DST[a]

• : Sputum smear examination
sm+ : Smear-positive
a : Smear- or culture-positivity at the fifth month or later (or detection of MDR-TB at any point) is defined as treatment failure and necessitates re-registration and change of treatment

(Source: Guidelines for TB treatment of WHO (WHO, 2010) and NTP (NTP, 2009))

2.5.5. Monitoring Activities

Monitoring activities are categorized into three sub-activities: routinely monitoring, special monitoring and suddenly monitoring. This activity is run based on the high levels monitor the lower levels. Following, provincial levels monitor district levels and communal levels. District levels monitor communal levels. Besides, the specimen inspection is also a special activity for the provincial level monitoring and assessing the activities of the lower levels and other sector.

2.5.6. Training Activities

Training activities are categorized into three sub-activities: Monthly briefing conferences, yearly updating conference, short-course training (for updating information, training for new staff, and retraining of existing staff).

2.5.7. Advocacy – Communication – Social Mobilization activities (ACSM)

ACSM activities are categorized into three sub-activities: Advocacy, Communication, and Social Mobilization. These activities are implemented at all levels of the public healthcare system under NTP and all private contracted healthcare facilities.

2.6. Public-Private Mixed Models

In Vietnam, according to the supports of WHO, public-private mixed models have been implemented by contracting with private healthcare facilities, develop the collaboration between public and private sectors, provided many specific guidelines, set up the coordination procedures logically that the private sector can effect on primary healthcare. The government has also built up a legal framework in the private medical practice area. In addition, they have been encouraged, assigned the responsibilities to participate in primary healthcare services and implement national health targeted programs, including supporting for TB treatments. Under PPM, TB treatments provided have to follow the recommended standards for TB treatment, diagnostic guidelines of WHO, as well as be monitored by state administrative institutes, etc. (NTP, 2007).

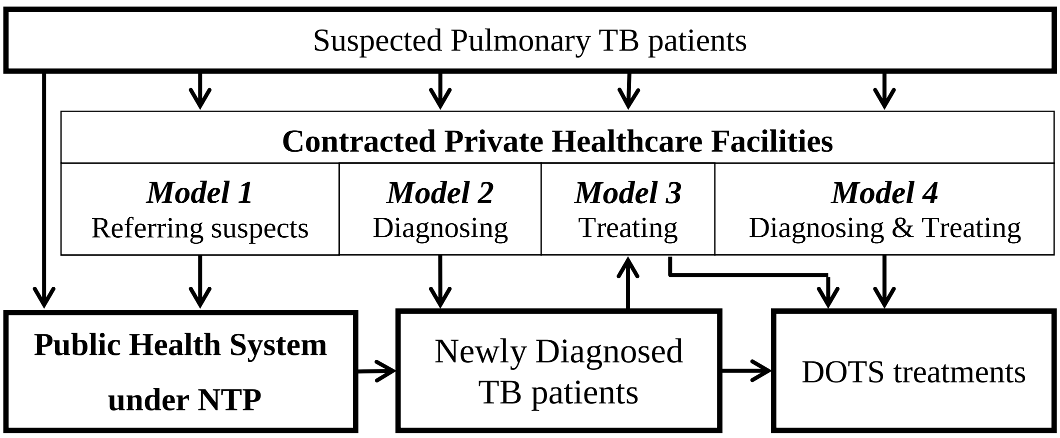
Before PPM implementation, the NTP was run under the previous TB system, in which there are only public healthcare facilities provided TB treatments following DOTS. The PPM models in Vietnam have been implemented since 2008, and in Ho Chi Minh City since 2009. PPM system substituted for the previous TB system does not mean the public healthcare system cannot provide TB treatment without private sector. In PPM, there are private healthcare facilities involved in providing TB treatment, and the public healthcare system still provides TB treatment as before PPM.

PPM system includes four models based on contracting between private or public healthcare facilities which had not been running under NTP with NTP system. Depending on the capacities and scope of each facility, contractors play different roles in TB treatment processes through four models (NTP, 2007), which are illustrated by the Figure 2.4 below:

- **Model 1**: TB suspects would be screened in contractors, and then, would be referred to the NTP system for detection and treatment. This model is the most common models in PPM in Vietnam nowadays.
- **Model 2**: TB suspects would be screened, diagnosed, detected in contractors, and then, would be referred to NTP system for treatment.
- **Model 3**: TB suspects would be screened, diagnosed, detected in NTP system, and then, would be referred to contractors for treatment.
- **Model 4**: TB Suspects would be screened, diagnosed, and treated in contractors.

There were 226 contractors under model 1, two contractors under model 2, no contractor under model 3, and 8 contractors under model 4. These details of contractors are provided in the Table 2.4 below.

Figure 2.4. Framework of Public-Private Mixed Models



In any models, public health system assigned to support for contractors in technology, drugs, laboratory materials and allowance based on number of cases, depending on annual contracts. The public health system has also responsibilities in training, monitoring, evaluating, and two-way communicating to private healthcare facilities. Responsibilities of each kind of providers in PPM models are summarized in the Table 2.5 below. The Table 2.6 below summarizes the characteristics and roles of public and private sectors in PPM models (NTP, 2007).

Due to insufficient data available separately for each kind of PPM models, this study could not compare between those models. Instead, the "PPM system" using in this study is standing for the combination of all four models together. This "PPM system" term is using in all the following chapters.

Table 2.4. Summary of number of contractors under each model in PPM in 2011

	Model 1	**Model 2**	**Model 3**	**Model 4**
Central general hospitals, hospitals under other sectors				3 (Cho Ray hospital, Police hospital 30/4, Military hospital 175)
Provincial public hospitals				4 (Nguyen Tri Phuong hospital, Tropical diseases hospital, GiaDinh people hospital, People hospital 115)
District public hospitals	22 (22/24 districts, except Cu Chi and Thu Duc districts)	2 (Cu Chi hospital, Thu Duc regional hospital)		1 (Thu Duc hospital)
District private hospital	8			
Private clinics	82			
Private drug stores	114			
Total	**226**	**2**	**0**	**8**

Table 2.5. Summary of the responsibilities of each kind of providers in PPM

	Responsibilities	NTP	Public health facilities	Private healthcare facilities / individuals	Private laboratory agencies	Pharmacies / drug stores
Clinical responsibilities	Symptom screening	X	X	X	X	X
	Sputum collection	X	X	X	X	X
	Referring TB suspects	X	X	X	X	X
	Cases report	X	X	X	X	X
	Treatment monitoring	X	X	X	X	X
	Sputum test	X	X	X	X	
	TB diagnostic and detection	X	X	X		
	Regimen judgment	X	X	X		
	Inform to TB patients	X	X	X		
Public health responsibilities	Identify and monitor the treatment supporters	X	X			
	Request compliance from withdrawing TB patients	X	X			
	Train healthcare provider	X	X			
	Activities monitoring	X	X			
	Lab quality assurance	X	X			
	Evaluation monitoring	X	X			
	Drug management and support	X				
	Financial management and regulation	X				

(Source: Guidelines for PPM implementation in NTP (NTP, 2007))

Table 2.6. Summary of the responsibilities in each modelof PPM

Model	Criteria of private healthcare facilities	Obligations / roles of private sector (private contractors)	Obligations / roles of public sector (public TB system)
Model 1 (Referring)	Apply for all facilities contracted to refer the TB suspects.	Symptom screening to identify TB suspects; Mobilize the patients go to public TB system for diagnosis and TB detection, refer them; Monthly report.	Diagnose and TB detect for all referred TB suspects from private sector; Respond to private sector; Register and treat for detected cases; Refer the non-TB cases back to private sector.
Model 2 (Diagnosing)	Apply for the facilities: Have lab for AFB sputum test certificated by DoH; Have trained laboratorial technician specifying for AFB test, who are certificated by provincial or central level TB systems; Committed to cooperate and to be monitored the quality of lab test by provincial level TB system.	Provide free AFB sputum tests for patients. Store all specimens for quality inspection; Refer AFB(+) PTB cases to public TB system for treatment registry; Refer the suspects of AFB(-) PTB, EPTB, children TB, or the cases are difficult to detect, to public TB system for diagnosing and TB detection; Report every three months.	Treatment register for AFB(+) PTB cases referred from private sector; AFB(-) PTB, EPTB, children TB detections; Refer the non-TB cases back to private sector; Monitor the testing technical process every three months. Specimen inspection monthly.
Model 3 (Treating)	Apply for the facilities: Have enough capabilities to treat and manage TB patients; Have trained health worker specifying for treatment monitoring,	Provide TB treatment including DOT and DOTS following NTP guidelines for TB patients referred from public sector; Counsel patients about TB treatment and the importance of compliance; Medication delivering and injecting (if it needed), guide and	Advice regimens, refer patients, and supply drugs to private sector; Cooperate with private sector to request re-treatment from the incompliant patients;

Model	Criteria of private healthcare facilities	Obligations / roles of private sector (private contractors)	Obligations / roles of public sector (public TB system)
	who are certificated by NTP; Committed to be monitored by NTP system.	monitor patient taken medication. Keep directly observing during using Rifampicin period; Request monitoring sputum tests during TB treatment from the patients at the end of the 2^{nd} (or the 3^{rd}) and the 5^{th} (or the 8^{th}) months of TB treatments; Request compliance from withdrawing TB patients, report to public sector; Monitor, determine, and handle the side effects of anti-TB drugs, unexpected special conditions. Refer the complicated cases, who they cannot handle, to the appropriate public healthcare facility Report to public sector	Handle the side effected or complicated TB patients; Train and technically support to private sector in TB treatments; Monitor TB treatment activities of private sector every three months.
Model 4 (Diagnosing and treating)	Apply only for the facilities, which meet all criteria of both the model 2 and the model 3.	Contain all obligations of the model 2 and the model 3	

(Source: Guidelines for PPM implementation in NTP (NTP, 2007))

CHAPTER III
LITERATURE REVIEW

3.1. Cost-effectiveness Analysis

Due to the limitation of resources, economic evaluation is essential for healthcare decision maker. Among economic evaluation methods, cost-effectiveness analysis is one of the basic useful tools for evaluating and assessing the effectiveness of healthcare program or health intervention (Drummond, Sculpher, Torrance, O'Brien, & Stoddart, 2007; Drummond et al., 2005; Muennig, 2008; WHO, 2003).

There are many guidelines for conducting cost-effectiveness analysis, mostly summarized into three distinct groups by Walker, D. in a published article in 2001: governments and pharmaceutical agencies (in Australia, Canada, United Kingdom, etc.), Peer-review journals (British Medical Journal – BMJ, Journal of the American Medical Association – JAMA, etc.), and developing country specialists (mainly concentrate for specific programs) (Walker, 2001; Wonderling, Sawyer, Fenu, Lovibond, & Laramee, 2011). , for conducting cost-effectiveness analysis focusing on TB programs in a developing country as Vietnam, WHO guidelines for CHOosing Interventions that are Cost – Effective (CHOICE) (WHO, 2003) are one of the most appropriate guidelines as published in 2000 by the lead author Murray et al. On "Generalized cost-effectiveness analysis" (Murray, Evans, Acharya, & Baltussen, 2000). Cost-effectiveness analysis can provide evidence for comparison of the outcomes of decision options in monetary term (Petitti, 2000).

Cost-effectiveness ratio is the measurement cost per unit of outcome. This ratio is the adjusted cost incurred respectively outcomes, and it is comparable for assessing two preventions, alternatives or strategies of treatments. Cost-effectiveness analysis mainly includes two components: Cost of healthcare program and its effectiveness. Extendedly, incremental cost-effectiveness analysis is recommended.

3.2. Costs of Healthcare Program

Cost analysis of healthcare program is the economic valuation of resources used in healthcare program and quantification of outputs produced by the program to explore total cost and cost per output unit of the program (Petitti, 2000).

Characteristics of healthcare program are including set of activities implemented by many departments and organizations varied duration of the program. A program has routine and ad hoc missions. Human resources are included permanent and temporary staff. Budgets of a program come from institutional and the program resources (Levin & McEwan, 2000). Costs of healthcare program regard to the study design (objectives, perspective, time horizon, sources of resources, budget used, types of costs), organization and activity identification, measurement, and valuation of resources used (Drummond et al., 2005).

3.2.1. Perspective

In costing healthcare program, there are many perspectives that the researchers can be based-on given variable results with many different points of view (Drummond et al., 2005). The perspectives that the researchers use mostly on over the world is program's (or provider's) perspective, and societal perspective (Muennig, 2008; Walker, 2001). Basing on this perspective has advantages if the objective of research focus on costing the national targeted healthcare programs, which are almost provide health services freely, so that most of costs bare by the health system. However, costs estimated in this perspective may miss an important component that the implicit cost, such as non-medical indirect cost, is mostly incurred by patients and caregivers. That cost component, if it is significantly high, may effect on the compliance of patients in some long-term treatments, indirectly impact on the effectiveness of healthcare programs. In the other hand, cost analysis in program perspective can cause heterogeneous because the intervention can reduce or increase costs (save or lose money) for program year by year in the long-run (Petitti, 2000). However, this problem cannot be exist for costing in one-year of healthcare program, and should not be considered.

Besides, the societal perspective is also popular through the Australian and Canadian Guidelines, as well as many articles published in The Journal of the American Medical Association – JAMA (Russell, Gold, Siegel, Daniels, & Weinstein, 1996; Siegel, Weinstein, Russell, & Gold, 1996; Weinstein, Siegel, Gold, Kamlet, & Russell, 1996). However, using this perspective in costing healthcare program is quite controversial. There were many researchers use the term "societal perspective", but instead they have just considered the healthcare payer or provider perspective. In cost-effectiveness analysis, the researchers should transparent their costing method, mostly regarding perspective (Neumann, 2009; Petitti, 2000).

3.2.2. Time horizon

The time horizon of cost analysis means to period of the program included in the analysis. It might be the whole period of the program or enough for assessing the effectiveness (Petitti, 2000). Normally, there are many researchers preferred the whole period for short-term intervention in those the costs and outcomes can be assessed only after the end of intervention, or one-year period for national targeted healthcare program.

3.2.3. Types of costs

Costs in healthcare program can be classified into many types of costs, depending on the objectives of costs, perspectives, and even on authors. The types of costs can be classified as below summarizing from many textbooks and guidelines (Drummond et al., 2005; Johannesson, 1996; Lipscomb, Yabroff, Brown, Lawrence, & Barnett, 2009; Muennig, 2008; Petitti, 2000; Phillips, Mills, & Dye, 1993; WHO, 2003).

Financial cost versus economic costs: Financial costs are including purchased inputs valuated by market prices in individual or organization perspectives, mostly reflect the expenditure and the funds required to cover. The economic costs are including all used resources valuated by “shadow price” or opportunity cost” usually in a societal perspective, reflect the value of the opportunities lost in using resources.

Fixed cost versus variable cost: Classifying costs into fixed costs and variable costs mostly based on the costs that changed respectively with the change of outputs. In short-term, fixed costs are defined as the costs unchanged respectively by the change of outputs, and variable costs are defined as the costs changed for each change of output. Otherwise, there are some costs called semi-fixed costs, which will be changed with the changed of a bundle of outputs. In the long-term, all costs are variable costs because everything can be changed.

Capital, labor, material costs: Capital costs are defined as the costs of capitals, which are used usually more than one year, such as cost of buildings, land costs, space costs, etc., and have to be depreciated during usage time. Labor costs are the costs incurred of labors, normally be measured by using salaries, allowances, shadow prices, opportunity costs, etc. Labor costs, normally, are included time costs. Material costs are measured by materials used initially or during operation.

Total, marginal costs: Total cost sums of all cost components. The marginal cost of an output unit is the additional costs for providing that unit of output.

Direct, indirect costs: Direct costs are the costs incurred directly for providing healthcare services, and indirect costs are the costs incurred indirectly. Indirect cost can be substituted by “productivity cost” because mostly, indirect costs incurred by patients are leading to reduce the productivity of both the patients and their caregivers. However, the “indirect cost” term is still generalizable.

Healthcare cost (medical cost) versus non-healthcare cost (non-medical cost): This classification is based on the relation between costs and healthcare provision in term of medicine. Healthcare costs or medical costs are costs related directly to a treatment, detection, laboratory test, drugs, etc. Non-healthcare costs or non-medical costs are the costs contributed to the healthcare system, but unrelated to medicine, such as training costs, monitoring costs, health education and communication costs, etc.

Start-up cost: this type of cost is the initial Lum-sum cost at the beginning of the intervention. However, most of cost-effectiveness with one-year time horizon didn’t count this type of cost due to costing the healthcare program which one had been set up for so long time.

3.2.4. Organization identification

A healthcare program may be implemented by various organizations at the same level, different levels, same ministry and different ministries. Those organizations provide different contribution to the program. For a comprehensive analysis, designing the scope of organizations included in analysis is very important.

3.2.5. Activity identification

Costs of healthcare program have been analyzed through separating into many activities. Every activity should be defined in detail, and if needed, it should be divided into sub-activities. The program's action plan will be very useful, or the researcher can re-identified these activities.

3.2.6. Identification, measurement and valuation of resources used

Based on the types of costs designed, we have to identify resources used in detail. To measure resources used, labor cost is quantified in a unit of man-hour, man-day, man-month or man-year. Equipment is measured as working hour. The building is measured in term of a square meter of space used. For valuation, we need unit cost of the resources for instance wage per hour, the capital cost per square meter (Creese & Parker, 1994; Kumaranayake & Watts, 2000; Petitti, 2000).

3.2.7. Special cost calculation

Social mobilization (campaign) as capital investment, start-up cost (e.g. Software development or training as capital investment, etc.). Composed of sub-activities and capitals, materials, labors. Estimation of useful years. Present value calculation of multi-year program.

3.2.8. Costing approaches

Reviewing the costing approaches over many textbooks, guidelines, as well as previous studies, there are six approaches popularly used or recommended with their own advantages and disadvantages: Micro-Costing (bottom-up) approach, Macro-Costing (Top Down) approach, Gross-costing approach, Incidence approach, Prevalence approach, Activity-based costing approach.

Micro-Costing (Bottom-Up) is an approach mainly based on identifying and specifying all of the resources that are used by individual patients. All treatment and service costs for a patient are allocated to that one case. In this approach, because the treatment and services provided some small differences, some similar cases may incur variety costs (Jacobs, 1999; Muennig, 2008). This approach may take so much time and quite difficult to correct the monetary value because this approach should involve the direct enumeration and costing out of every input consumed (Petitti, 2000).

Macro-Costing (Top Down) is a common approach referred to as "average" costing. The method takes total healthcare expenditures and divides it by a measure of the total services provided (the output) to determine a cost per patient (Jacobs, 1999).

This approach has some limitation based on market price (fee schedules or average payment or charges) (Petitti, 2000).

Gross-costing approach is quite often in practice. Using this approach, the total cost of intervention and its alternatives will be summed from measured amount of used inputs, which are the most relative, their estimated typical costs, and assigned costs of each input (Petitti, 2000). In this approach, costs are collected from electronic datasets or medical literature. In some events, micro-costing approach can supply for gross-costing approach because no gross cost estimates are available. This approach may be easier and less time-consuming than micro-costing approach. However, there is a risk of overlooking important costs (Muennig, 2008).

"Incidence" and "prevalence" are special terms, mostly known as epidemiological indicators. These approaches normally used for evaluating the costs and outcomes related specifically to health state, usually in the cost of illness analysis. As the definition in term of epidemiology, prevalence costs have to be estimated in a fixed calendar time period, normally in one-year, using the prevalence of disease at the end of the year. Otherwise, the incidence costs have to be estimated for a fixed duration from the point of diagnosis, capturing whole treatment of newly detected individuals, and may be extended for several years in long-time treatment duration. Using the prevalence approach is quite attractive for policy makers and healthcare payers or providers while the incidence approach has seemed useful in patient's perspective (Barlow, 2009; Lipscomb et al., 2009).

Activity-based costing is a costing approach base on the cost drivers incurred for specific activities. This approach focuses on measuring the costs through classifying into many sets of activities in healthcare program, identifying resources used for these activities, and assigning costs (Baker, 1998; Brazier, Ratcliffe, Salomon, & Tsuchiya, 2007; Drummond et al., 2007). For costing healthcare program, this approach is adopted as more appropriate than other approaches. Precisely defining and reflecting used resources is one of the obvious advantages of this approach. However, this approach is quite new, and much more complicated due to many allocation bases (Muto et al., 2011).

3.3. Effectiveness of TB Program

The outputs of the program can be classified as intermediate and final outputs. We should cover both kinds of the output, if possible. In some cases, we can identify outputs in different dimensions. Healthcare programs, mostly, seem as interventions with many outcomes, including treatment successes, detection through screening tests, prevented people, complications reduction, etc. Widely, health interventions are assessed by the incidence, prevalence rates, or, improvement of quality of life or life expectancy, etc. Furthermore, especially in economic evaluation, health outcomes can be assessed by QALYs (Quality Adjusted Life-Years) (Russell et al., 1996; Siegel et al., 1996; Weinstein et al., 1996; Wonderling et al., 2011), healthy years (Drummond & Jefferson, 1996), QALE (Quality Adjusted Life-Expectancy), DALYs (Disability Adjusted Life-Years) adverted (Phillips et al., 1993), HRQL (Health Related Quality-of-Life) score (Wonderling et al., 2011), death-averted (using life year gained – LYG), etc. (Eichler, Kong, Gerth, Mavros, & Jönsson, 2004; Muennig, 2008). The outcomes normally be used for analyzing the effectiveness of health program are regarded to epidemiological or clinical indicators, such number of patients with treatment success, incidence rate, prevalence rate, death averted, life-years gained (measured through death averted and life expectancy). Other advanced indicators, such as QALYs, QALE, DALYs adverted, etc. are usually used in term of utility, which one is used in cost-utility analysis as a specific type of cost-effectiveness analysis (Petitti, 2000).

3.4. Incremental cost-effectiveness analysis

Incremental cost-effectiveness analysis (ICEA), measuring the incremental cost-effectiveness ratio (ICER), is an advanced step used in cost-effectiveness analysis (CEA), measuring the cost-effectiveness ratio (CER), in the purpose of evaluating the impacts of an intervention. While the CER measure the difference of cost regarding to outcome between two interventions, the ICER provides the difference of costs respectively to the difference in effectiveness between two interventions (Bambha & Kim, 2004; Cantor & Ganiats, 1999). CER can reflect the production efficiency, in conditions that all resources used for producing products, by measuring the amount of cost incurred in achieving one unit of outcome. ICER can reflect the allocatiing efficiency, in conditions that the resources are allocated efficiently to produce the demanded products, by measuring the amount of additional costs incurred and the additional outcomes achieved if a new intervention are added into the conventional program or system (Cantor & Ganiats, 1999; Eichler et al., 2004; Petitti, 2000).

3.5. Cost-effectiveness of TB treatments

3.5.1. DOTS treatment effects on TB status

Cost-effectiveness analysis in TB treatment following DOTS strategy is a necessary evaluation for NTP in many countries, especially in developing countries and HBCs in Africa and Asia. DOTS reduced 99.98% of the infectivity burden of disease, 89.19% of YLL, and 78.9% of YLD in Beijing, China (Xu, Wu, Jin, & Zhang, 2002), 50% prevalence and mortality between 1990 and 2010 in sub-Saharan Africa, between 2000 and 2010 in South East Asia (R. Baltussen, Floyd, & Dye, 2005). Besides, DOTS increased treatment completion rates to 79%, slightly higher than self-administered therapy (71%) in Rio de Janeiro, Brazil as a published article of Steffen, R. et al. in 2010 (Steffen et al., 2010).

DOTS strategies are also evaluated more cost effective for TB treatments in the comparison with non-DOTS strategies. Using US dollar (US$) of the year 2002, an article published by Floyd, K. et al. in 2006 found out that TB treatment provided by public sector cost US$123 for DOTS compared with US$172 for non-DOTS per patient treated in India, and the average cost per successfully treated patient in public sector DOTS was US$140 compared with US$338 for non-DOTS private sector treatment (Floyd et al., 2006).

Otherwise, a study provided a special comparison between 6HE regimen and 4HR regimen, which is recommended by WHO, for the continuation phase in TB treatment in Uganda, was published in 2012 by author Manabe, Y. C. et al. Using US dollar in 2008, in healthcare system perspective, including costs of drugs and clinic visits, new TB case’s treatment cost US$12.77 for 6HE and US$13.66 for 4HR. The expected average cost of TB treatment in the continuation phase was US$26.07 for 6HE, which compared to US$23.64 for 4HR. The expected cost savings associated with 4HR were US$2.42 per patient. Furthermore, their model predicted an expected mortality rate of 13.3% associated with 6HE treatment and 8.8% associated with 4HR treatment. Including treatment for MDR-TB as an additional outcome for previously treated patients with unfavorable outcomes increased the average cost to US$65.86 for 6HE and to US$53.12 for 4HR. The cost difference between the 6HE and 4HR treatment options increased to US$12.74 per patient. The expected mortality increased slightly to 13.5% and 8.9%, respectively, and 4HR continued to be the dominant treatment strategy (e.g. Lower cost and lower mortality) relative to 6HE (Manabe et al., 2012).

3.5.2. Smear-positive pulmonary TB treatment

DOTS treatment for newly AFB+ TB cases are cost effective strategy. In 2000, using US$ in 2000, a published article by Xu, Q. et al. showed that DOTS for newly AFB+ TB treatment saved more ten times than non-DOTS per DALY averted (CN¥45.7 versus CN¥471.4 per DALY averted, approximate US$5.52 versus US$56.95 per DALY averted, respectively) in Beijing, China (Xu, Jin, & Zhang, 2000). In Thailand, during 1996-1997, author Kamolratanakul, P. et al. reported that the provider cost of newly AFB+ TB treatment per patient was from THB7,020 to THB12,539 (Kamolratanakul et al., 2002). According to author Baltussen, R., et al. reported in 2005, using the international dollar (I$) in 2000, cost of newly AFB+ TB cases in DOTS program are around I$6-8 per DALY averted in Africa and I$7 per DALY averted in South East Asia at coverage levels of 50-95% in the context of the millennium development goals (R. Baltussen et al., 2005). In Kenya, included all costs of health services, patients, family members, and community, using US$ in 1998, author Nganda, B. et al. reported that the costs per patient for new AFB+ TB treatment were from US$209 to US$591 (Nganda, Wang'ombe, Floyd, & Kangangi, 2003).

3.5.3. Smear-negative and extra-pulmonary TB

DOTS treatment of AFB- PTB and EPTB cases are also highly cost effective. Reported by author Kamolratanakul, P. et al. in 2002, provider costs of AFB- cases were from THB3,916 to THB7,727, and cost of re-treatment TB cases were from THB9,696 to THB16,679 per patient in Thailand during 1996-1997 (Kamolratanakul et al., 2002). Including treatment of AFB- PTB and EPTB cases at a coverage level of

95%, the cost of TB treatment was I$95 in Africa, and I$52 South East Asia per DALY adverted (R. Baltussen et al., 2005). According to the study of author Nganda, B. et al. mentioned above, new AFB- PTB and EPTB treatment cost from US$197 to US$311 per treated patient (Nganda et al., 2003).

3.5.4. Directly observe supervisor

There are some studies compared cost-effectiveness of TB treatment in DOTS between different direct observers (supervisors) used during treatment. An article of author Khan, M. A. et al. Published in 2002 concluded that the DOTS using community health worker have the highest effectiveness in term of cured rate (67%) with slightly higher costs per case than the self-administered group, which have the highest cost-effectiveness, (US$172 compared with US$164 per cured case) in Pakistan. DOTS using health facility-based health workers as the direct observers are the least cost effective (US$310 per cured case) (Khan, Walley, Witter, Imran, & Safdar, 2002).

Furthermore, in a published article of author Prado, T. et al. in 2011, they concluded that guardian-supervised DOTS was even more attractive than community health worker supervised DOTS in term of cost per patient treated (US$398 compared with US$548, respectively), and the cured and completed rate was significantly higher (98% versus 83%, respectively) in Vitoria, Espirito Santo State, Brazil (Prado et al., 2011). The same conclusion in another article published by Nieto, E. et al. in 2012 found out that home-based guardian supervised DOTS cost from US$1,122.4 to US$1,152.7 per cured case, compared with US$1,137 to US$1,494.3 for DOTS without a home-based guardian supervises from a societal perspective (Nieto et al., 2012).

3.5.5. TB treatments base on different healthcare system levels

Decentralization in TB treatments has some positive effects in term of cost-effectiveness. DOTS in different levels of the healthcare system have different effects. In Kenya, analyzing until 1997, using US dollar in 1998, author Nganda, B. et al. found out that the costs of TB treatment in decentralized systems (community and primary healthcare system) fell more than 60% in comparison with the conventional hospital-based approach to care from all perspectives for both newly AFB+ TB and AFB- TB or EPTB patients (Nganda et al., 2003).

Included both costs of healthcare services and patients, author Vassall, A. et al. reported in 2002 that DOTS implemented through the primary healthcare system was slightly lower cost per cured case than through specialist clinics (US$258 versus US$297 per cured case, respectively) in Egypt. In Syria, cost-effectiveness of DOTS implemented through these alternatives was significantly different (US$243 versus US$693 per cured case, respectively) (Vassall, Bagdadi, Bashour, Zaher, & Maaren, 2002). Collected data by using a structured questionnaire, interviews, and documentaries, author Moalosi, G. et al. concluded that TB treatment under home-based care was more affordable and cost effective than hospital-based care. Using US dollar in 1998, in the health system and caregiver perspective, they estimated that in general, the cost per patient treated was reduced 44% in home-based care compared with hospital-based care (US$1,657 versus US$2,970, respectively), specifying for caregivers is 23% (US$551 versus US$720, respectively), and for the health system is 50% (US$1,106 versus US$2,206, respectively), in Francistown, Botswana (Moalosi et al., 2003).Author Wandwado, E. et al. had the same conclusion in an article published in 2005. Using US dollar in 2002, they found that the total cost of TB treatment in DOTS from the perspective of health services, patients, and community were US$145 and US$94 per treated patient for health facility-based treatment and community-based treatment, respectively, in Dar Es Salaam, Tanzania (Wandwalo, Robberstad, & Morkve, 2005). Whereas, total cost from a societal perspective for each AFB+ TB treatment success was US$158.9 in health facility-based treatment compared with US$61.7 in community-based treatment (using US dollar in 2007) in Southern Ethiopia, as authors Datiko, D. G. and Lindtjorn, B. reported in 2010 (Datiko & Lindtjorn, 2010).

3.5.6. Drug resistant TB

Re-treatment and drug resistant TB treatments are high cost in many countries, as well as high cost per outcome in the comparison with other types of TB patients, especially in developing countries in Asia and Africa. The highest cost component in MDR-TB treatment is drug cost due to high drug price and extending treatment time.

DOTS-Plus treatments of multidrug resistant cases with individualized drug regimens were also highly cost effective, could be feasible, comparatively effective in low- and middle-income countries.

Using US dollar in 2008, an article of author Manabe, Y. C. et al. published in 2012, found out that a completed course of re-treatment regimen, involved the additional 8-month drug-regimen re-treatment after the failure initial treatment, cost US$110.7 per patient in Uganda (Manabe et al., 2012).

Among all types of patient, cost of multi-drug resistant TB (MDR-TB) treatments are the highest. During 1996-1997, a research of author Kamolratanakul, P. et al. in Thailand, published in 2002, found out that the average total provider cost of MDR-TB treatment was THB89,735.49 per patient, and was 17 times higher than the cost of AFB- cases. Anti-TB drug costs (THB65,870 per patient) were 95 times higher than the cost for AFB- cases (Kamolratanakul et al., 2002). Another study also established in 1997 and published in 2002 of author Suarez, P. G. et al. found out that NTP in Peru cost US$0.6 million per year for MDR-TB treatment. Cost per completed treatment MDR-TB patient was US$2,381, and cost per DALY gained was US$211 at a mean (adjusted as drug price in 2002, this cost was US$165) (Suarez et al., 2002). The addition of DOTS-Plus treatment for MDR-TB cases, the cost of TB treatment was I$123 in Africa, and I$226 in South East Asia per DALY averted (R. Baltussen et al., 2005).

In 2012, a systematic review in MDR-TB treatments of author Fitzpatrick, C. and Floyd, K. using 424 studies from many countries in many languages was published. They concluded that in low- and middle-income countries, MDR-TB treatments could be cost effective. Following, using international dollar and US dollar in 2005 (I$ and US$), cost per patient for MDR-TB treatment in Tomsk (Russia), Philippines, Peru, and Estonia were US$14,657, US$3,613, US$2,423, US$10,880, respectively. Cost per DALY were estimated at US$745 (I$1,059), US$143 (I$255), US$163 (I$291), US$598 (I$960), respectively. In comparison of inpatients and outpatients, they concluded that without strong evidence of the necessity of hospitalization for achieving high rates of adherence to treatment, MDR-TB treatments should be used mainly ambulatory care (Fitzpatrick & Floyd, 2012).

Otherwise, a study provided a special comparison cost-effectiveness of MDR-TB treatment between using the second-line drug regimens following first-line drug regimen failures and using the first-line drug regimens only, published by author Resch, S. C. et al. in 2006. They found that the incremental cost-effectiveness ratio of the standardized second-line treatment is US$720 per QALY, US$8,700 per death averted compared to DOTS. Individualized second-line drug treatment for MDR TB following first-line failure provided more benefit at an incremental cost of US$990 per QALY, and US$12,000 per death averted, compared to the standardized second-line treatment. They concluded that the second-line drug is highly cost-effective for MDR-TB treatment in Peru (Resch, Salomon, Murray, & Weinstein, 2006). With the same conclusion, author Tupasi, T. E. published an article in 2006 showed that the DOTS-Plus in Manila, Philippine, cost US$3,355 per treated patient from a health system perspective, US$537 per treated patient from a patient perspective, and US$242 per DALY gained at mean (ranged from US$85 to US$426) (Tupasi et al., 2006).

3.5.7. PPM models

Following WHO's guidelines for Public-Private Partnership, the structures of PPM models in many HBCs are almost similar. There are four models for different purposes, in which the roles and responsibilities of private sector are different. These are referring model, diagnosing model, treating model, and comprehensive model (Ardian et al., 2007; Arora, Lonnroth, & Sarin, 2004).

The first model, which focuses on finding TB cases and referring TB suspects, are reported as the most successful model in term of clinical benefits with significant improvement of TB cases finding, detections and treated rate (Ardian et al., 2007; Arora et al., 2004). In South India from 2001 to 2003, author Balasubramanian, R. et al. found out that the rate of AFB+ TB patients, who were suspects referred by private trained practitioners, was 24% compared to 10% by self-reported patients ($p < 0.001$ suggested that this difference was very significant). The detection rate increased by nine per hundred thousand population (Balasubramanian et al., 2006). Also in India, other article published in 2005 by author Kumar, M. K. et al. also reported that there were 17% of 2,328 pulmonary TB patients registered detected in the private sector, increased new AFB+ TB cases notification rate by 21% from 2000 to 2002 (Kumar et al., 2005).

"PPM system", using standing for the combination of all four PPM models, is an incentive and has effect to shift TB patients from non-DOTS to DOTS treatment. Implementing PPM system can be cost-effective and reduce the financial burden of TB patients. A study of author Pantoja, A. et al. published in 2009 demonstrated for that statement. Collected data from 1999 to 2005 of TB treatments under NTP in Bangalore City, India, they found out that the implementation of PPM system shifted more than seven thousand TB patient from a non-DOTS to DOTS treatment over five years. Using US dollar in 2005 from provider perspective, they estimated the cost per TB patient was US$69 in PPM, compared with US$71 in pre-PPM TB treatment system (Pantoja et al., 2009). Another article of authors Sinanovic, E. and Kumaranayake, L. concluded that PPM could significantly reduce 64% to 100% costs to the TB patients from US$700-1000 to US$354-979 per patient, and reduce government financing required per TB patient from US$609-690 to US$36-139 (Sinanovic & Kumaranayake, 2006) in South Africa.

3.5.8. Summary

DOTS strategies are cost effective in almost countries, especially in the developing countries and HBCs. The effectiveness of DOTS was clearly shown through reducing the TB infectivity burden, prevalence, mortality rate, increasing the TB treatment completion rate in many countries. The Table 3.1, Table 3.2, Table 3.3, and Table 3.4 below are summarizing the articles reviewed in this study focusing on cost-effectiveness of each type of TB treatment, kinds of direct observers in DOTS, as well as PPM system.

Table 3.1. Summary for CER of each type of TB treatment (1)

Author	**Study place**	**Perspective**	**Newly AFB+ PTB**		**AFB-/EPTB**	**Re-treatment TB**
			DOTS	**non-DOTS**		
Xu, Q. et al. *(2000)*	China		CNY45.7***	CNY471.4***		
Kamolratanakul, P. et al. *(2002)*	Thailand	Provider	THB7,020-12,539*		THB3,916-7,727*	THB9,696-11,679*
Nganda, B. et al. *(2003)*	Kenya	Society	US$209-591*		US$197-311*	
Baltussen, R., et al. *(2005)*	Africa		I$6-8***		I$95***	
	SEA		I$7 ***		I$52 ***	
Floyd, K. et al. *(2006)*	India	Provider	US$123* US$140**	US$172* US$338**		
Manabe, Y. C. et al. *(2012)*	Uganda					US$110.7*

*   *: cost / treated patient*
** *: cost / cured or treatment completed or treatment success*
*** *: cost / DALY*

Table 3.2. Summary for CER of each type of TB treatment (2)

Author	**Study place**	**MDR**
Kamolratanakul, P. et al. *(2002)*	Thailand	THB 89,735 *
Suarez, P. G. et al. *(2002)*	Peru	US$ 2,381 **; US$ 211 ***
Baltussen, R., et al. *(2005)*	Africa	I$ 123 ***
	South East Asia	I$ 226 ***
Fitzpatrick, C. & Floyd, K. *(2012)*	Tomsk, Russia	US$ 14,657 *; US$ 745 (I$ 1,059) ***
	Philippines	US$ 3,613 *; US$ 143 (I$ 255) ***
	Peru	US$ 2,423 *; US$ 163 (I$ 291) ***
	Estonia	US$ 10,880 *; US$ 598 (I$ 960) ***

*   *: cost / treated patient*
** *: cost / cured or treatment completed or treatment success*
*** *: cost / DALY*

Table 3.3. Summary for CER of each type of direct observer

Author	Study place	Perspective	Health facility-based	Community/primary-based	Home-based / Self-administered
Khan, M. A. et al. *(2002)*	Pakistan		US$ 310**	US$ 172**	US$ 164**
Vassall, A. et al. *(2002)*	Egypt		US$ 297**	US$ 258**	
	Syria		US$ 693**	US$ 243**	
Moalosi, G. et al. *(2003)*	Botswana	Overall	US$ 2,970*		US$ 1,657*
		Health system	US$ 2,206*		US$ 1,106*
		Caregiver	US$ 720*		US$ 551*
Prado, T. et al. *(2011)*	Brazil			US$ 548*	US$ 398*
Nieto, E. et al. *(2012)*		Society	US$ 1,137-1,494.3**		US$ 1,122.4-1,152.7**

*   *: cost / treated patient*
**   *: cost / cured or treatment completed or treatment success*
***   *: cost / DALY*

Table 3.4. Summary for CER of PPM system

Author	Study place	Perspective	PPM	Non-PPM
Pantoja, A. et al. *(2009)*	India	Provider	US$ 69*	US$ 71*
Sinanovic, E. & Kumaranayake, L. *(2006)*	South Africa	Patient	US$ 354-979*	US$ 700-1,000*
		Government	US$ 36-139*	US$ 609-690*

*   *: cost / treated patient*
**   *: cost / cured or treatment completed or treatment success*
***   *: cost / DALY*

CHAPTER IV
RESEARCH METHOD

4.1. Study Design

This study is conducted based on prevalence-based cost-effectiveness analysis from the healthcare system perspective. Activity-based costing method is used to cost in all levels of the healthcare system under NTP. This study also analyzes the incremental cost-effectiveness to evaluate the cost effectiveness of public-private mixed models implemented in the TB program in Ho Chi Minh City.

4.2. Target and Study Populations

Ho Chi Minh City is the most appropriate place to conduct this study. As mentioned in the background, Ho Chi Minh City is an economic central in the Southern Vietnam with the highest average population and population density. The people in Ho Chi Minh City face risk of TB infection, and the healthcare system faces many difficulties in TB control. The prevalence of TB patients in Ho Chi Minh City is still high, and the forms of TB patients are varied. Otherwise, under NTP in Ho Chi Minh City, every TB patient who involved in will receive free treatment (excluding hospitalization and other drugs out of NTP's list) (NTP, 2009).

The targeted population is all population of Ho Chi Minh City, including all people who are living and under the coverage of NTP in Ho Chi Minh City, and excluding people who are migrating temporary.

The study population is all people who were seeking TB treatments at all healthcare system levels (from provincial levels to communal levels) under NTP in Ho Chi Minh City. This study excludes people who are detected in Ho Chi Minh City, but will be referred to other provinces because it will be double counting when the result of this research will be applied on national wide.

4.3. Type of Data

This study uses a retrospective secondary data collection.

4.4. Data Collection

Data are collected from Pham Ngoc Thach TB and Lung Diseases Hospital, the TB Units of Preventive Medicine Centers in 24 districts, 322 Communal Health Centers, and all contractors in the private sector under public-private mixed models, for this study in Ho Chi Minh City, Vietnam. For costing, the data are collected retrospectively from financial reports as well as activity reports of NTP. Data on the effectiveness of this program are collected retrospectively from activity reports of NTP in Ho Chi Minh City during the fiscal year 2012. Data will be separated into PPM and the conventional model, which is assumed that the private healthcare facilities did not participate in the TB treatment system. All data were collected from three sources.

4.4.1. Patient's data from medical records

Available medical records of the patients, who were detected and registered in TB treatment in Ho Chi Minh City's TB program system, were collected in the years 2010 and 2011 (the first year and the second year after the year 2009, start point of public-private mixed implementation in Ho Chi Minh City, Vietnam).

For testing the hypothesis whether the pattern and structure of TB patients were different over year, this study would use chi-squared and t-test, and report the p-value at the 5% significance level.

4.4.2. Ho Chi Minh City Tuberculosis Program's reports

The reports collected from TB management department, financial department, drugs and supplies department. These reports contain treatment outcome reports in 2012 (reported treatment outcome of the TB patients who registered in 2011), screening and detecting reports in 2011, activities reports in 2011, asset auditing reports in 2011, drug and medical supplying reports in 2011, financial reports of TB program in 2011, human resources reports in 2011. These reports were directly providing information for costing and measuring effectiveness of TB program in Ho Chi Minh City in 2011. From these reports, the direct costs information and input information for calculating indirect costs and opportunity costs was extracted.

4.4.3. Qualitative data from in-depth interviews and direct observations

There were 30 in-depth interviews conducted using unstructured questions, including nine interviews at provincial level, 18 interviews at district level, and 3 interviews at communal level. The collected information was mostly the allocation criterion of human resources for each activity, as well as for TB program compared with the other programs.

Allocation criterion of the capital costs, such as the percentages of using time of medical equipment, percentages of space and land areas used for TB program, were collected by directly observing healthcare facilities through all levels. There are 1 provincial hospital, 3 district TB units (1 in rural area, 2 in urban area), and 3 communal healthcare centers (1 in rural area, 2 in urban area) were observed.

4.5. List of assumptions

Due to insufficient available data, measuring the effectiveness of TB program in this study is basing on a list of assumptions

- In 2011, PPM has already conducted, so that the "Previous TB system" mentioned in this study is assumed that there are only public sector under NTP was running in the year 2011, and covered all population in the same condition with PPM.
- The TB prevalence, incidence, mortality rate caused by TB in Ho Chi Minh City in 2011 is assumed to be exactly the same with the whole nation in WHO's Global Report for the year 2011, published in 2012, specified for Vietnam. Accordingly, the numbers of all TB patients, newly TB patients, deaths cause by TB are calculated by multiplying these rates with the total population of Ho Chi Minh City in the year 2011. These numbers are assumed exactly the same for both the PPM system (the current TB system) and the previous TB system. This assumption supported to assess the effectiveness of these systems standardizing for the same condition.
- This study is assuming that all TB patients would seek and be involved in screening process, meaning that the number of screened suspects is containing the number of all estimated TB patients.

- All the TB patients are assumed to be registered immediately when they are detected as the Vietnamese National TB management guideline. Due to this assumption, the number of registered TB patients is assumed to be equal to the number of detected TB patients in this study.
- All TB patients dying during TB treatment is assumed caused by TB, not because of other diseases. The other diseases mentioned in this assumption are containing the diseases of other organs, such as liver, kidney, heart, etc. heart attached, high blood pressure, HIV/AIDS, DOWN, diabetes, obesity, gout, bronchial asthma, cancer (except lung cancer). The other diseases mentioned here are not contained any kind of accident because this kind of death cause has been already excluded in data due to the interruption of TB treatment records. In facts, the proportion of TB patients got other diseases and died at all is very small, and might not impact on this study, anyways.

4.6. Conceptual framework

The health system is divided into two main sectors, public and private sectors.

The public sector is classified into four levels, Central level, Provincial level, District level, and communal level. At the Central level, TB program contains only the National hospital of Tuberculosis and Lung Diseases, which one placed in Hanoi Capital. Each province has its own provincial hospital of Tuberculosis and Lung Diseases, or the provincial center for Controlling and Preventing Social Diseases (combined TB program management) in some provinces. Every district has one TB unit, which seem as primary healthcare level for TB treatment, in the District Preventive Medicine Center. In communal level, there is one Communal Health Center, in which the national targeted health programs are implemented and managed at primary level (including TB program). Each Communal Health Center covers for each commune. Besides, specifying for TB program, in other general hospitals or the hospitals under other sector in every level, there is one TB unit linked to official TB treatment systems to provide TB treatments in each hospital.

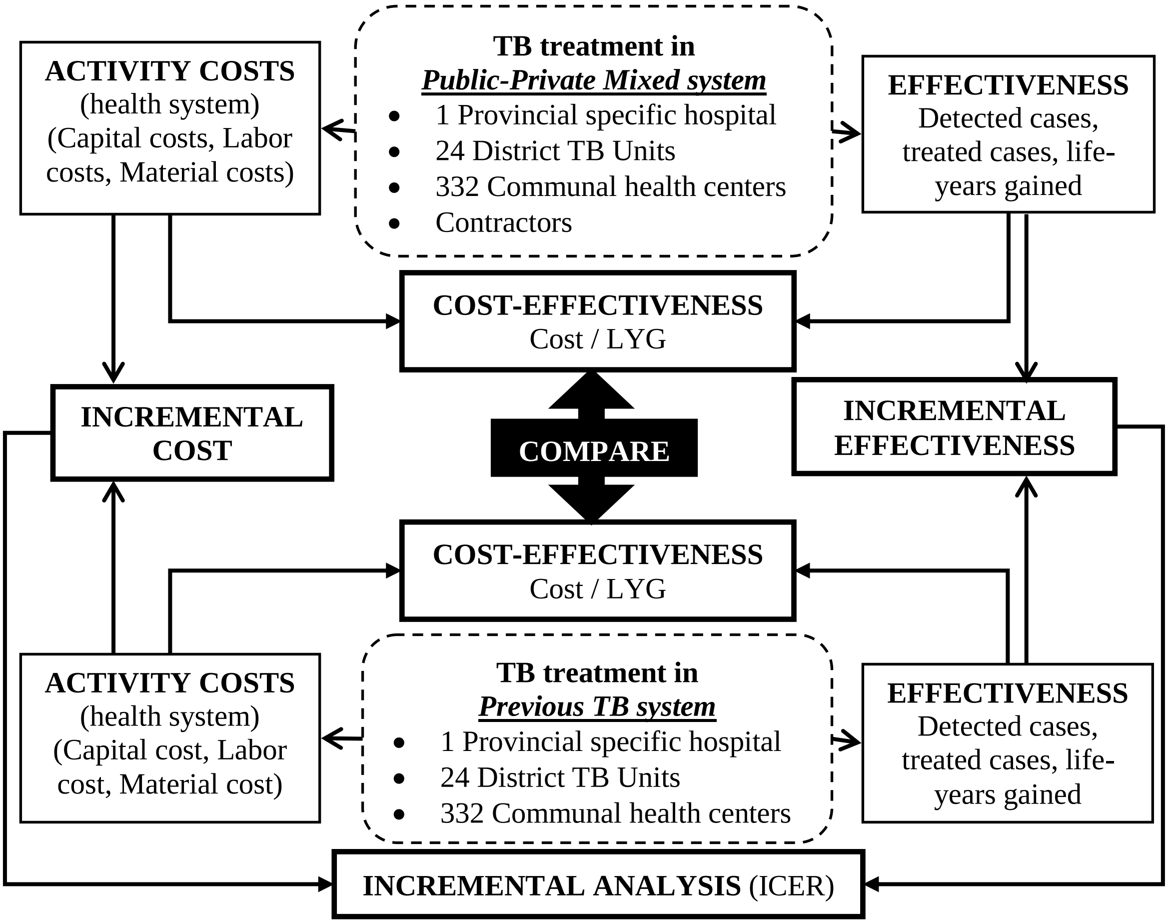
In addition, NTP assigns two hospitals to manage and monitor NTP activities implemented in all three areas of Vietnam. One of these two hospitals is the National hospital of Tuberculosis and Lung Diseases. It is also the highest level of NTP management in Vietnam, managing and monitoring NTP activities of the Northern (area A) and the Middle (area B1) of Vietnam. The other one is Pham Ngoc Thach hospital. Although Pham Ngoc Thach Hospital is the provincial hospital of Tuberculosis and Lung Diseases in Ho Chi Minh City, it also represents for NTP to manage and monitor NTP activities of the Southern (area B2) of Vietnam.

The private sector in the TB program involves all private clinics, pharmacies, drug stores, etc. those contracted with public sector under NTP in any model of PPM.

This study is focusing on comparing the PPM system to the previous TB system, in both cost and effectiveness of TB treatment under NTP. The PPM system in TB program is a combined system of all four PPM models in which there are co-operations of contractors for providing TB treatments following DOTS in any models. Conventional public TB system and contractors in PPM system are linked and supporting to each other. The previous TB system under NTP is the system in which TB treatments are assumed to be provided by public sector under NTP only. The Figure 4.1 below illustrates for the conceptual framework using in this study.

A hypothesis was employed in this study that PPM system implemented might be increasing the detection rate, treated rate, reducing the cost per outcome, and increasing cost effective of TB program in Ho Chi Minh City.

Figure 4.1. Conceptual framework of study



4.7. Costing Method

Costing and outcomes of the program will base on estimations from collected data of the resources. General costing information is collected from financial reports for calculating the direct cost and estimating allocation cost. Otherwise, for special costing and specific activity-based costing, the information is collected from other concerned departments, such as a human resources department, inpatient departments, outpatients department, etc. as well as other concerned organizations.

Costs measured in this study contained both the explicit financial costs and implicit economics costs, which are measured through opportunity costs using shadow price and market price as the proxies. The opportunity costs components are measured flexibly based on the real number of resources used and the estimated unit costs of resources used, which will reflect the potential interests if these resources are invested in the market instead be used in TB program. This type of costs should be adjusted by inflation.

The monetary values of costs in this study was in VND initially, and exchanged into USD by using the USD exchange rate at the end of 2011, when the exchange rate had been officially provided by the Ministry of Finance in Vietnam. The exchange rate was 20,803, meaning that 20,803 VND would be exchanged by an USD in 2011.

Cost components of each activity are calculated by multiplying the amount of resources used by the unit cost of resource, assigned cost from jointed cost using allocation criterion specifying for each kind of resource, etc. Unit costs of resources are estimated by different calculations from different approaches depending on the different characteristics of each activity, and the availability of data collected.

4.7.1. Cost definitions

Based on the perspective, costs of treatments exclude any non-medical cost components and the costs related to patients. Cost of treatment contains all direct medical costs. The direct medical cost is defined as cost directly associated with the provision of healthcare. Estimating costs of treatment is summing all costs of all activities. To estimate and collect adequately, the costs of each activity are divided into three main categories: capital costs, material costs, labor costs.

4.7.2. Activity identification and organization identification

All costs components in this study synthesized from many sources including both estimated costs and aggregated costs based on resources used in six main activities in TB program. These are

- Administrative activities;
- Monitoring activities;
- Infection control, ACSM, training, and researching activities;
- Screening activities;
- Detecting activities; and
- Treating activities.

The costs of the program will include related costs in all levels of health system and sub-system that involved in TB treatments under NTP. However, following the roles of each level in the healthcare system assigned by NTP, activities are implemented unequally at each level, identified in the Table 4.1 below. Administrative and supportive activities will be allocated by step-down allocation costing method for all activities. Capital costs, material costs and labor cost such as opportunity costs of used space, cost of equipment, salaries, etc. will be allocated by percentage purpose of usage. Activities implemented at each level of the healthcare system are shown below.

Table 4.1. Identification of the activities implemented at each level of healthcare system

Levels	**Activities**		
	Treating	*Screening and detecting*	*Others*
Public Health system under NTP			
PNT	Yes	Yes	Yes
DTBU	Yes	Yes	Yes
CHC	Yes	No	Yes
Contracted health facilities			
Model 1	No	Yes (excluding laboratory)	No
Model 2	No	Yes	No
Model 3	Yes	Yes (excluding laboratory)	No
Model 4	Yes	Yes	No

(PNT: Pham Ngoc Thach hospital; DTBU: District TB Unit; CHC: Communal Health Center)

Among those activities, costs are also derived from direct costs and allocated costs of capital, labors, and materials.

The administrative activities, monitoring activities, IC, ACSM, training, and researching activities are incurring in the public TB system only, from provincial level to communal level. So these cost components incurred in PPM system, which is mentioned as a combination of all four PPM models, is the same with the previous TB system, in which there are only public sector assuming to be involved in TB program in 2011.

4.7.1. Cost components

In each activity, costs components are measured from direct costs and allocated costs. All costs components are including capital costs, labor costs, and material costs. All costs incurred in provincial level are allocated 80% for TB program in Ho Chi Minh City only because the provincial level in TB system in Ho Chi Minh City is assigned to manage and monitor TB program's activities of twenty-one other provinces in the Southern of Vietnam.

4.7.1.1. Capital costs

Capital costs are measured by estimating opportunity costs of areas used. The opportunity costs are estimated by multiplying the areas used by the shadow land price in 2011 specifying for the location on that the land used are located, respectively. The costs of medical equipment incurred in the year 2011 are also derived from the equivalent annuity depreciation basing on their life span and values at the beginning of the year 2011 through the shadow price of them on market.

4.7.1.2. Labor costs

Labor costs are measured by two components. These are salaries regulated by the Ministry of Finance, and specific bonus regulated by the Ministry of Health. Because the pay rolls are confidential, this study has to use opportunity salaries instead of the real salaries, and of course, this is one limitation of this study. The opportunity salaries are calculated by multiplying the based-salaries by a complex of salary-ratio, retiring compensation ratio, specific ratio for working for TB program, and responsibility ration, if any. These ratios are differently specifying for different kind of health care worker depended on their education status, experience, level of risk, etc. Specific bonuses allowanced to health worker regulated by the Ministry of Health and the Ministry of Finance through the circular 147 provided in 2007. This kind of bonus almost based on the number of screened suspects, detected TB patients, treated TB patients, etc.

4.7.1.3. Material costs

Materials costs are including the drugs costs, chemistries, medical supplies costs, stationery costs, and costs of fuels. These costs are calculated by multiplying the used amount by their price in 2011.

4.7.2. Cost of Diagnosing activities

Cost of diagnosing activities includes all costs of its sub-activities (three diagnostic algorithms), such as symptom screening, sputum smear test, chest radiography test. These contain capital costs, labor costs, and material costs. The costs of this activity are incurred in provincial levels, district levels and some private contracted health facilities under PPM model 2 and model 4.

Capital costs are including opportunity costs of spaces used for diagnosing estimated from the area in square meters, depreciation and maintenance of buildings, medical equipment, and laboratory equipment.

Material costs are including all supportive materials for examining, diagnosing, sputum smear test, chest X-Ray (such as globes, masks, alcohol 90^o, etc.).

Labor costs are included salaries and allowances for all staffs regarding to diagnosing activities, such as department administrators, doctors, medical assistants, nurses, laboratory technicians, radiology technicians, etc.

4.7.3. Cost of Treating activities

The cost of treating activities includes treatments by drugs, treating management, directly observing and laboratory costs during treatments. The costs of this activity are incurred in all levels of the healthcare system, and some contracted health facilities under NTP. However, drug costs are only incurred by PNT, and other cost components are incurred unequally in different levels. These costs contain costs of anti-TB drugs, and costs of labor who involved in treating processes.

Capital costs are including opportunity costs of spaces used for inpatient (in some severe case, DR-TB and TB/HIV, patients are hospitalized), depreciation and maintenance of buildings, medical equipment, laboratory equipment.

Material costs are including all supportive materials for treating (such as drugs, globes, masks, alcohol 90^o, etc.), as well as materials for sputum smear monitoring and chest X-Ray during treatment. Drug costs defining as a component of material costs are estimated based on the prevalence of TB patients at the beginning of the year 2012, also based on the incidence of TB patients in 2012. Dosage and regimens as well as a number of drugs are estimated based on case definitions of registered TB patients adjusted by patients’ age and weight at the beginning of treatments. Drugs are counted for whole treatments, including both intensive phase (initial phase) and continuation phase. Cost of drugs is calculated by using purchasing drug price of NTP.

Labor costs are included salaries and allowances for all staffs directly regarding to treating activities, such as department administrators, doctors, medical assistants, nurses, laboratory technicians, radiology technicians, etc.

4.7.4. Cost of Monitoring activities

Monitoring activities are categorized into three sub-activities: routinely monitoring, special monitoring and suddenly surveillance. Monitoring activities mainly implemented and incurred cost at provincial and district levels of the public healthcare system. Another component of monitoring activity is the specimen inspections.

The costs of this activity include material costs for monitoring form preparation, laboratory material for specimen inspections, and labor cost such as salaries, allowances and diem for monitoring staffs. The costs of this activity are based on monitoring times in a month, year, number of staffs involved in monitoring processes, number of specimens inspected.

4.7.5. Cost of Advocacy – Communication – Social Mobilization (ACSM) activities

ACSM activities are categorized into three sub-activities: Advocacy, Communication, and Social Mobilization. These activities are implemented at all levels of the public healthcare system under NTP and all private contracted healthcare facilities.

Capital costs are including opportunity costs of spaces for conducting conferences, seminars, etc. depreciation and maintenance of equipment (such as printer, photocopy machines, etc.). A special cost component should be considered as capital cost is annual on-time paid cost for public mass multimedia.

Material costs are included stationery, printing materials for producing communicating and informing posters, banners, brochures, etc.

Labor costs include salaries, allowance, compensation for communication staffs at all public healthcare system under NTP and some contracted communication networks.

4.7.6. Cost of Training activities

Training activities are categorized into three sub-activities: Monthly briefing conferences, yearly updating conference, short-course training (for updating information, training for new staff, and retraining of existing staff). Almost this activity is implemented and incurred costs at provincial levels (training for lower level systems and private sectors) and district levels (updating information for CHC staffs) of the public healthcare system under NTP.

Capital costs are including opportunity costs of spaces for conducting conferences, training courses, etc. depreciation and maintenance of equipment (such as printer, photocopy machines, etc.).

Material costs are included stationery, printing materials for producing guidelines, etc.

Labor costs are included salaries, allowance, compensation for administration staffs, conference participants, reporters, trainers, trainees, etc.

4.8. Measuring Effectiveness

Effectiveness of TB program under NTP includes two main types of outcomes: detected patients and successful treatment cases, which are defined as the summing of cured cases and treatment completed cases (NTP, 2009; WHO, 2010).

The model will estimate another type of outcome which is life year gained (LY gained). Although detected TB patients and treatment success cases are outcomes of TB program under NTP (NTP, 2009; WHO, 2010), the recommended effectiveness measurement in cost-effectiveness analysis is outcome related to mortality or morbidity, such as life year gained (LYG), quality-adjusted life years (QALYs), disability-adjusted life years (DALYs). LYG is calculated from the remaining life expectancy at the point of each averted death. Using life table specifying for Vietnam, LYG is calculated by multiplying the number of treatment success at each certain year of age to the life expectancy in that certain year of age, respectively.

4.9. Discount, Depreciation, and Inflation Adjustment

This study did not discount any costs as all costs incurred within one year.

Due to the rising prices irrespective with the recurring costs, such as salaries, wages, or allowances of labors, the inflation adjustment should be considered for measuring the costs over time. The most common price index used for adjusting inflation is the Consumer Price Index (CPI). Using CPI, the Equation 4.1 below is used to calculate the inflation adjusted cost.

Equation 4.1. Formula for calculating the inflation adjusted cost using CPI

$$Cost\ in\ year\ b = \ cost\ in\ year\ a \times inflation\ rate\ of\ year\ b = cost\ in\ year\ a \times \frac{(CPI_b - CPI_a)}{CPI_a}$$

Where b is the year when the cost is measured for, a is the year when the costs were incurred, and CPI_b is greater than CPI_a.

There are some costs need to be adjusted for inflation because these direct costs were collected from asset auditing reports with the costs from some year ago. The CPI data of Vietnam using in this study were provided by The World Bank in 2013. The Table 4.2 below is summary of CPI data.

Table 4.2. Consumer Price Index of Vietnam (2005 = 100)

Year	CPI	Year	CPI	Year	CPI
1996	70.8872124	2001	79.9654266	2007	116.302876
1997	73.162356	2002	83.0287648	2008	143.187817
1998	78.4784777	2003	85.7021997	2009	153.289086
1999	81.7095169	2004	92.3519459	2010	166.872952
2000	80.3120086	2006	107.385787	2011	198.040609

(Source: World Development Indicators (The World Bank, 2013))

4.10. Incremental Cost-Effectiveness Analysis

Incremental costs of public-private mixed models are estimated the difference between total costs of the whole program and the estimated cost of the whole program in assumption if program excluded roles of private sectors. Excluding costs can be in all activities in which there are any contributions of private sectors and incurring costs for public health system caused by private sectors.

Incremental or marginal cost-effectiveness analysis is an advanced step in cost-effectiveness analysis, in which the incremental cost and the incremental effectiveness are considered to estimate the incremental cost-effectiveness ratio. The incremental cost-effectiveness ratio is estimated following the Equation 4.2 below.

Equation 4.2. Formula of Incremental Cost-Effectiveness Ratio

$$ICER = \frac{IC}{IE} = \frac{C_I - C_C}{E_I - E_C}$$

Where ICER is an incremental cost-effectiveness ratio, IC is incremental cost, IE is incremental effectiveness, C_I and E_I are the cost and the effectiveness when the intervention is operated, C_C and E_C are the cost and the effectiveness of the conventional operation of healthcare program.

4.11. Decision tree model

Basing on the scope of this study and the insufficient available data, this study is focusing on the initial year only with the first part of the decision tree model illustrated in the Figure 4.2 below. All TB patients in the year 2011 (initial year) assumed to seek and be screened as the third assumption mentioned in section 4.5 above had two chance nodes that they could be detected (chance node 2), or not (chance node 3). Detected TB patients had two chance nodes that they could be treated (chance node 4), or not (chance node 5). Among undetected cases (chance node 5) and untreated cases (chance node 3), TB patients had two terminal nodes that they could be still remaining alive and continuously involved in the next year cycle as active TB cases, or died (repeat process from node 1, and so forth). Among treated patients (chance node 4), TB patients had many outcomes divided into two groups as successful treated patients (including cured cases and completed treatment) with only one "alive" terminal node, and unsuccessful treated (including defaulted patients and failure in treatment) with two terminal nodes as "dead" or "alive". The successful treated patients who are alive in the initial year can be relapsed in some year later as described in the chance node 7, or non-relapsed with the "alive" terminal at the end. Describing in the decision tree model, the defaulted patients, failure TB treatments, or relapsed after successfully treated TB patients of the initial year can be continuously involved in TB re-treatment as the previously treated TB patients in the next year or some year later, or not (repeat process from node 2, and so forth).

This decision tree model is employed for analyzing PPM system, which is the combination of all four PPM models with the cooperation of public healthcare system and contractors under NTP, and the previous TB system, in which TB treatments were provided following DOTS by the public healthcare system under NTP only.

4.12. Sensitivity analysis

This study's result is facing some uncertainties because the data and information used for cost-effectiveness analysis was collected from non-sampled secondary data sources (R. M. Baltussen, Hutubessy, Evans, & Murray, 2002). All cost components and effectiveness were collected and estimated without any sampling method lead to each of them can be variable among its range.

Hence, variability of each parameter alone with the others keeping constant, or all parameters varying together simultaneously, can effect on the variability of ICER in term of life-years gained. The sensitivity analysis could deal with these uncertainties and reflect the robustness of this study's results (Jain, Grabner, & Onukwugha, 2011).

This study would like to test which parameters have the greatest influence on a model's results. In this case, each parameter in the model could be changed by a specific amount, say that all parameters were to be increased and decreased by 20% of their original value. For each parameter change, this study might record the percentage impact on the model's main outcome, which can be shown graphically in the form of a tornado diagram.

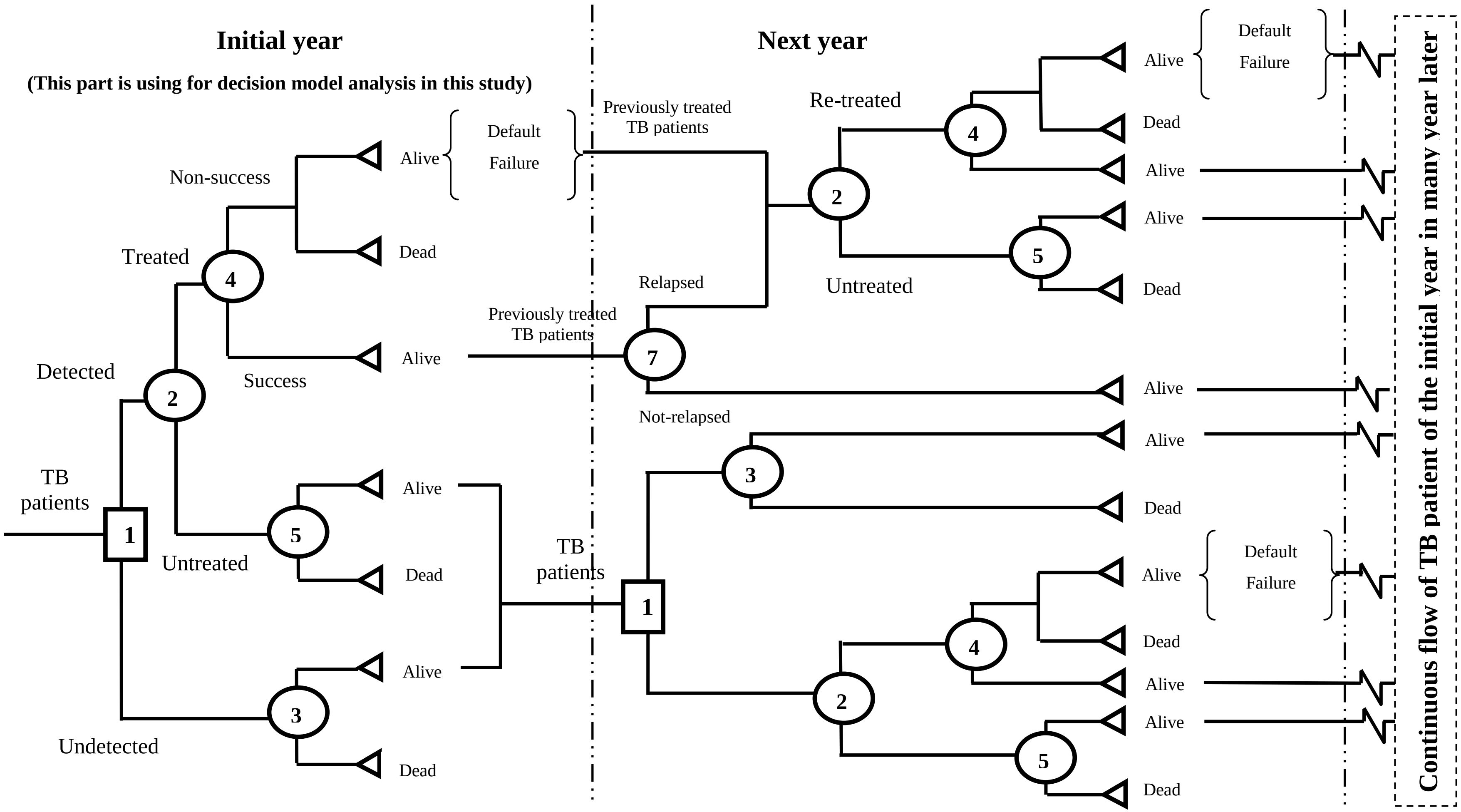
As the mentions above, one-way sensitivity analysis is still limited due to providing the change of one parameter one time with the rest of parameters keeping constant. In fact, all parameter could be changed simultaneously with the random value in their range. Providing a comprehensive sensitivity analysis, this study also provided probabilistic sensitivity analysis. In probabilistic sensitivity analysis, rather than assigning a single value to each parameter, it is necessary to assign a distribution to all parameters in the model. The ranges are determined by the average value, or the standard error, or the 'shape' of the spread of data.

In this study, two techniques of sensitivity analysis below employing for the decision tree model, which is mentioned in section 4.11 above, are One-Way sensitivity analysis and Probabilistic Sensitivity analysis

- One-way sensitivity analysis with Tornado diagram will analyze the sensitivity of ICER if each parameter is varying alone; and
- Probability sensitivity analysis with Monte Carlo simulation and scatter plots of the difference in costs respecting with difference in life-years gained will analyze the variability of ICER if all parameters varying together simultaneously.

This study also provided the cost-effectiveness acceptability curve (CEAC). The CEAC is applying on the probability sensitivity analysis result, basing on willingness to pay (WTP). This technique assesses the probability of being cost effective of PPM TB system comparing to the previous TB system, respecting to the WTP.

Figure 4.2. Decision tree model



CHAPTER V
RESULTS

5.1. Characteristics of TB patients in Ho Chi Minh City

There are 13,960 observations among 16,073 registered TB patients in 2010, and for 2011 are 13,945 among 17,950 registered TB patients available. Analyzing these data, the characteristics of TB patients are summarized in Table 5.1, Table 5.2, Table 5.3 below.

Table 5.1. Characteristics of TB patients in Ho Chi Minh City, Vietnam, in 2010 and 2011 (1)

	% 2010	% 2011
Gender		
Male	70.15	69.42
Female	29.85	30.58
Occupations		
Military	00.28	00.42
Illiterate	00.04	00.00
Student	06.52	06.73
Civil servant	05.54	06.18
Factorial worker	13.92	13.55
Business	07.67	07.27
Retired / elderly / disability	11.86	11.54
Farmer	00.72	01.18
Unemployed	09.00	08.32
Housewife	06.99	07.30
Driver	03.14	02.92
Liberty	32.83	33.19
Private worker	00.06	00.00
Religious servant	00.09	00.06
Children	00.01	00.00
Tailor	01.22	01.28
Penitentiary	00.12	00.06

	% 2010	% 2011
Age groups		
00-04	00.01	00.04
05-09	00.00	00.01
10-14	00.08	00.08
15-19	04.09	03.99
20-24	11.00	10.90
25-29	15.88	14.91
30-34	12.92	12.49
35-39	10.42	10.39
40-44	10.10	10.07
45-49	09.05	09.93
50-54	08.80	08.74
55-59	05.93	06.62
60-64	03.53	03.72
65-69	02.38	02.54
70-74	02.29	02.17
75-79	01.71	01.58
80-84	01.17	01.20
85-89	00.39	00.48
90-94	00.16	00.13
95-99	00.05	00.01
≥ 100	00.01	00.00

Table 5.2. Characteristics of TB patients in Ho Chi Minh City, Vietnam, in 2010 and 2011 (2)

		Mean	SD	25%	Median	75%	Min	Max
Weight	**2010**	48.71	8.45	43	48	54	20	92
	2011	49.07	8.86	43	48	54	20	120
Age	**2010**	40.09	15.61	28	37	50	1	100
	2011	40.53	15.56	28	38	51	3	

Table 5.3. Characteristics of TB patients in Ho Chi Minh City, Vietnam, in 2010 and 2011 (3)

	% 2010	% 2011
Anatomical, bacterial types of TB		
AFB+	59.68	59.78
AFB-	17.21	18.26
EPTB	23.10	21.96
TB/HIV		
Yes	01.70	01.94
No	98.30	98.06

	% 2010	% 2011
Historical types of TB		
Newly	79.32	79.25
Retreat after relapsed	09.81	09.75
Retreat after failure	01.60	01.74
Retreat after defaulted	00.64	00.64
Transferred in	03.57	03.67
Others	05.06	04.96
Children	00.01	00.00
Tailor	01.22	01.28
Penitentiary	00.12	00.06

These results showed common characteristics of registered TB patients. There were mostly male patients contributed around 70%, and equal around 2.3 times in comparison with female patients. The average age of TB patients was around 40 years-old, the rage from 20 years-old to 60 years-old contributed around 85%, especially, sub-range from 28 years-old to 50 years-old contributed around 50%. The proportion of TB patients with HIV among registered TB patients was not high, just around 2%. The liberal occupation took the highest proportion among registered TB patients (contributed over 30%). There are around 80% of registered TB patients got newly TB. The proportion of PTB patients had AFB+ was higher than PTB had AFB- and EPTB. The average weight of TB patients was around 50 kilogram.

5.2. Resources used

The costing was done basically through three steps. These are identifying, measuring, and valuating the resources used for TB program in Ho Chi Minh City in 2011. Resources used for TB program were identified for each level of TB system, as provincial level, district level, communal level. Due to the complication of accessing resource data, and the complexity to separate the resources used from private sector for TB program only from their whole operation system, this study would have to estimate the resources used from contractors under TB program as approximately as able. The resources used were measured separately for each level and contractors. There were containing capital, labor, and materials used for TB program. In provincial level of TB system, Pham Ngoc Thach hospital was not covering only for Ho Chi Minh City, but also partially for other twenty-one provinces in The Southern of Vietnam. In addition, in the communal healthcare centers, all resources used for many healthcare programs, including TB program. Measuring the real resources used for TB program in Ho Chi Minh City only, the capitals and human resources would be allocated by using allocation criterion from interviews, and materials can be measured separately for Ho Chi Minh City, so that they would not be allocated.

Capitals was including the building and medical equipment, which are using for more than one year. However, all buildings using for TB program are too old and almost finish their life span, and so far, there are no budget or any funding for maintenance these building in 2011, so that these buildings are expected non-valuable. In this study, instead using their own value, using opportunity cost of the areas used for TB program is more referable. The areas used for TB program are summarized in Table 5.4 below.

Besides, medical equipment and some other equipment using for more than one year measured in this study are biological safety cabinets, microscopes, specimen’s storage boxes, other machines and furniture. There are some machines, furniture overused exceedingly their life span, so that they would not counted in this study due to their values was estimated non-valuable at the studying time. The number of these medical equipment is summarized in Table 5.5 below.

Table 5.4. Summary of areas used for TB program

Level	Examination area	Laboratory area	DOTS treatment area	Pharmaceutical area	Conference area, offices, libraries
Provincial	180.00	77.00	20.00	200.00	460.00
District	764.98	457.38	793.34	247.00	0.00
Communal	0.00	0.00	402.00	94.00	0.00
Contractors	2,092.98	145.88	160.00	1,676.00	0.00
Total	3,037.96	680.26	1,375.34	2,217.00	460.00

Table 5.5. Summary of equipment used for TB program

Equipment	Branch	Number	Life span
Biological safety cabinets	Vietnamese Technology	34	10
Microscopes	Olympus CX021	38	10
Specimen's storage boxes	Vietnam	232	10
Others		431	
Total		735	

Table 5.6. Summary of human resources used for TB program

Level	Provincial	District	Communal	Contractors	Total
Medical doctors	11	28	53	140	232
Medical doctor assistants	10	44	164	0	218
Pharmacist	1	0	0	16	17
Pharmacist assistants	1	18	0	0	19
Nurses	0	40	86	140	266
Lab technicians	16	29	0	21	66
Public health officers	3	0	0	0	3
Medical secretaries	2	0	0	0	0
Others	0	8	20	15	43
Total	44	167	323	332	864

The human resources used in TB program are collected from human resources' report in 2011, containing reports from provincial level, district level, and communal level. For measuring human resources used from contractors, it is so complex because among very huge number of total healthcare workers working for these contractors, there are only some of them really working for TB program, and they are not fully employed for only TB program. With the limited accessibility to contractors' human resource data, especially in private sector, estimated numbers of each professional kind of healthcare workers in contractors basing on the number of screened suspects respected to available data from public sector are the most appropriate. The numbers of each professional kind of healthcare workers are summarized in Table 5.6 above.

Table 5.7. Summary of materials used for TB program

1st-line drugs	**Unit**	**Amount PPM**	**Amount Public only**
Trepmycin 1g	Tube	694,971	361,106
Isoniazide 300mg	Tablet	3,421,028	1,777,560
Turbezid (RHZ) 150/75/400 mg	Tablet	4,833,133	2,511,287
Ethambutol 400 mg	Tablet	10,431,417	5,420,145
Turbe (RH)150/100mg	Tablet	802,745	417,105
Chemistry, other materials			
Fucshin basic 100g	Kg	3.9	2.5
Blue methylene 100g	Kg	3.9	2.5
Microscopy's oil 500ml	Liter	25.8	16.6
Phenol 250g	Kg	64.5	41.5
HCl 500ml	Liter	38.7	24.9
Pipette sucker	Item	110	71
Bio-stick (50 stick / box)	Box	5,161	3,318
Centrifuge tube (50ml) 500 item / box	Box	18	11
Centrifuge tube (15ml) 500 item / box	Box	11	7
Smear	Item	258,042	165,878
Sputum cup	Cup	258,042	165,878
Drinking cup	Cup	1,243,935	646,346
X-Ray film	Roll	27	27
IEC materials	Item	1,004	1,004
Fuel	Liter	4129.82	4129.82

Materials measured in this study are including mostly drugs, chemistries, medical supplies, stationeries, estimated fuel amount. The amount of drugs, chemistries, and medical supplies are summarized in Table 5.7 above separately for PPM and estimated amount if there is only public sector involved in TB system.

5.3. Activity-based costing

5.3.1. Administrative activities

The capital costs of administrative activities are including opportunity cost of space used, and one-year depreciation of some equipment used, allocated for administration in provincial level, district level, communal level of public TB system. Total capital cost allocated for administration is 18,504,746,969 VND (around 889,523 USD in 2011).

The labor costs of these activities are including the allocated opportunity cost estimated through shadow salaries of all kind of human resources used, and allocated for administration in provincial level, district level, communal level of public TB system. From provincial level, there is a special cost for admiration in order to encourage healthcare workers in TB program is considered as labor cost. Total labor cost allocated for administration is 1,604,223,345 VND (around 77,115 USD in 2011).

The material costs of administrative are including printing cost of documentaries, distributed from provincial level to other lower levels. The stationery cost of provincial level is 33,680,057 VND (around 1,619 USD in 2011), containing all material cost of administration.

The allocation criterions are summarized in the Table 5.8 below.

Table 5.8. Allocation criterion capital costs for administrative activities

	Provincial	District	Communal
Capital costs			
Conference rooms	30%	N/A	N/A
Offices	70%	N/A	N/A
Examination rooms	0%	10%	N/A
Laboratories	20%	20%	N/A
DOTS rooms	0%	20%	20%
Drug stores	0%	15%	10%
Microscopes	20%	0%	N/A
Specimen storage boxes	N/A	100%	N/A
Some equipment	70%	0%	0%
Labor costs			
Medical doctors	20%-100%	20%	10%
Medical doctor assistants		20%	
Nurses		20%	
Lab technicians		10%	
Pharmacist assistants		10%	
Others		20%	

N/A: Not applicable

5.3.2. Monitoring activities

The capital costs of monitoring activities are including opportunity cost of space used, and one-year depreciation of some equipment used, allocated for monitoring in provincial level, district level, communal level of public TB system. Total capital cost allocated for monitoring activities is 5,471,667,469 VND (around 263,023 USD in 2011).

The labor costs of monitoring activities are including the allocated opportunity cost estimated through shadow salaries of all kind of human resources used, allocated for monitoring in provincial level, district level, communal level of public TB system. From provincial level, there were some compensation for routinely monitoring the lower levels, the staying fee, per diem fee for routinely monitoring nineteen prisons, educational centers for criminal youths, etc. belongings to Ho Chi Minh City, as well as the compensation for specimen inspection are considered as labor cost. In addition, the district TB units were monitoring ten times yearly for each ward. The allowances for the monitors are also considered as labor costs. Total labor cost allocated for monitoring is 1,793,385,024 VND (around 86,208 USD in 2011).

The material costs of monitoring activities are including fuel cost of transportation for monitoring that (1) The provincial level monitored district level, communal level, some randomly selected patients; (2) The district level monitored communal level, some randomly selected patients; and (3) The communal level monitored all patients they were managing. Besides, from provincial level, the road fees caused by monitoring nineteen routinely monitoring nineteen prisons, educational centers for criminal youths, etc. belongings to Ho Chi Minh City are also considered as material costs. Total material cost of monitoring activities is 38,402,338 VND (around 1,846 USD in 2011).

The allocation criterions are summarized in the Table 5.9 below.

Table 5.9. Allocation criterion capital costs for monitoring activities

	Provincial	**District**	**Communal**
Capital costs			
Offices	20%	N/A	N/A
Laboratories	20%	0%	N/A
Drug stores	20%	0%	0%
Microscopes	20%	0%	N/A
Specimen storage boxes	N/A	100%	N/A
Some equipment	20%	0%	0%
Labor costs			
Medical doctors	20%-70%	10%	20%
Medical doctor assistants		10%	
Nurses		10%	
Lab technicians		5%	
Pharmacist assistants		0%	
Others		10%	

N/A: Not applicable

5.3.3. Infection control, ACSM, training, researching activities

The capital costs of these activities are including opportunity cost of space used, and one-year depreciation of some equipment used, allocated for these activities in provincial level, district level, communal level of public TB system. Total capital cost allocated for these activities is 6,070,981,096 VND (around 291,832 USD in 2011).

The labor costs of these activities are including the allocated opportunity cost estimated through shadow salaries of all kind of human resources used, allocated for these activities in provincial level, district level, communal level of public TB system, and the allowance for participants in conferences and meetings. From provincial level, there are special costs for allowance 370 participants and four reporters in three quarterly conferences, one finalized conference, and one meeting for The World's TB Day with 100 participants and three reporters are considered as labor cost. For The World's TB Day, twenty-four district TB units also have one meeting with 70 participants and one reporter in each district. In addition, the district TB units were training ten times yearly for each ward with 40 participants and one reporter each time. The allowance for participants and reporters are also considered as labor costs. Total labor cost allocated for these activities is 5,913,856,037 VND (around 284,279 USD in 2011).

The material costs of these activities are including the documentary cost for two researches, four conferences, twenty-five meetings, and printing cost of eighty banners for The World's TB Day. All these materials were produced and incurred costs in provincial level, distributed to other lower levels. Total labor cost allocated for these activities is 108,487,645 VND (around 5,215 USD in 2011).

The allocation criterions are summarized in the Table 5.10 below.

Table 5.10. Allocation criterion capital costs for IC, ACSM, training, researching activities

	Provincial	**District**	**Communal**
Capital costs			
Conference rooms	70%	N/A	N/A
Offices	10%	N/A	N/A
Libraries	100%	N/A	N/A
DOTS rooms	0%	10%	0%
Other equipment	10%	0%	0%
Labor costs	20%-100%	20%	20%

N/A: Not applicable

5.3.4. Screening activities

The capital costs of screening activities are including opportunity cost of space used of examination areas and drugs stores used, allocated for screening activities in provincial level, district level, communal level of public TB system, and contractors.

Total capital cost allocated for screening activities is 13,574,394,363 VND (around 652,521 USD in 2011) for PPM, and 9,532,745,917 VND (around 458,239 USD in 2011) for the system which is assumed that there are only public sectors involved in TB program.

The labor costs of these activities are including the allocated opportunity cost estimated through shadow salaries of all kind of human resources used, allocated for screening activities in provincial level, district level, communal level of public TB system, and contractors.

From provincial level, there are five medical doctors and medical doctor assistants used for screening suspects in nineteen prisons, educational centers for criminal youths, etc. belongings to Ho Chi Minh City. For screening these special places, their per diems are also considered as labor cost. In addition, there is a kind of bonus money for the examiner who screened and found the AFB+ patients. Amount of this bonus was calculated from total number of screened suspects found as AFB+ patients. Total labor cost allocated for screening activities is 9,044,062,644 VND (around 434,748 USD in 2011) for PPM, and 1,948,908,252 VND (around 93,684 USD in 2011) for the system which is assumed that there are only public sectors involved in TB program.

The material costs of screening activities are including fuel cost and road fee of transportation for the provincial level to screen suspects in nineteen prisons, educational centers for criminal youths, etc. belongings to Ho Chi Minh City. From district level, communal level, and contractors, there is no material cost allocated for screening activities. Total material cost of screening activities is 36,800,507 VND (around 1,769 USD in 2011) for PPM, and the same amount for the system which is assumed that there are only public sectors involved in TB program.

The allocation criterions are summarized in the Table 5.11 below.

Table 5.11. Allocation criterion capital costs for screening activities

<table>
<tr><th></th><th>Provincial</th><th>District</th><th>Communal</th><th>Contractors</th></tr>
<tr><td>Capital costs</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Examination rooms</td><td>80%</td><td>50%</td><td>N/A</td><td>100%</td></tr>
<tr><td>Drug stores</td><td>5%</td><td>5%</td><td>20%</td><td>5%</td></tr>
<tr><td>Labor costs</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Medical doctors</td><td>30%</td><td>20%</td><td rowspan="6">20%</td><td rowspan="6">30%-100%</td></tr>
<tr><td>Medical doctor assistants</td><td>30%</td><td>20%</td></tr>
<tr><td>Nurses</td><td>0%</td><td>20%</td></tr>
<tr><td>Lab technicians</td><td>0%</td><td>0%</td></tr>
<tr><td>Pharmacist assistants</td><td>0%</td><td>5%</td></tr>
<tr><td>Others</td><td>0%</td><td>20%</td></tr>
</table>

N/A: Not applicable

5.3.5. Detecting activities

The capital costs of detecting activities are including opportunity cost of space used of laboratories and drugs stores, and one-year depreciation of microscopes and biological safety cabinets used, allocated for detection in provincial level, district level, communal level of public TB system, and contractors. Total capital cost allocated for detecting activities is 16,019,995,043 VND (around 770,081 USD in 2011) for PPM, and 12,417,872,381 VND (around 596,927 USD in 2011) for the previous TB system.

The labor costs of these activities are including the allocated opportunity cost estimated through shadow salaries of lab technicians, pharmaceutical workers, and other healthcare workers used, allocated for detecting activities in provincial level, district level, communal level of public TB system, and contractors. From provincial level, there are sixteen lab technicians used for detecting in nineteen prisons, educational centers for criminal youths, etc. belongings to Ho Chi Minh City. For detecting these special places, their per diems, bonus for healthcare workers who took sputum tests, chest X-Ray, and detected AFB+ patients are also considered as labor cost. In addition, there is a kind of bonus money for the lab technicians who detected the AFB+ patients with three AFB+ smears. Amount of this bonus was calculated from total number of AFB+ patients with three AFB+ smears. Total labor cost allocated for detection is 1,188,577,064 VND (around 57,135 USD in 2011) for PPM, and 976,363,876 VND (around 46,934 USD in 2011) for the system which is assumed that there are only public sectors involved in TB program.

The material costs of detecting activities are including fuel cost and road fee of transportation for the provincial level to screen suspects in nineteen prisons, educational centers for criminal youths, etc. belongings to Ho Chi Minh City, and chemistry and medical supplies for detection from provincial level, district level, communal level, and contractors. From district TB units, there is 3.15% allocated fuel costs for importing chemistries and medical supplies also considered as material cost of detecting activities. Total material cost of screening activities is 1,290,326,878 VND (around 62,026 USD in 2011) for PPM, and 807,239,612 VND (around 38,804 USD in 2011) for the system in which there are only public sectors involved.

The allocation criterions are summarized in the Table 5.12 below.

Table 5.12. Allocation criterion capital costs for detecting activities

	Provincial	**District**	**Communal**	**Contractors**
Capital costs				
Laboratories	50%	60%	N/A	60%-100%
Drug stores	15%	5%	0%	30%
Microscopes	50%	70%	N/A	70%
Biological safety cabinets	100%	70%	N/A	70%
Labor costs				
Medical doctors	0%	0%	0%	10%-100%
Medical doctor assistants	0%	0%		
Nurses	0%	0%		
Lab technicians	80%	55%		
Pharmacist assistants	0%	25%		
Others	0%	0%		

N/A: Not applicable

5.3.6. Treating activities

The capital costs of treating activities are including opportunity cost of space used of examination areas, laboratories, drugs stores, DOTS areas and one-year depreciation of microscopes and biological safety cabinets used, allocated for treating in provincial level, district level, communal level of public TB system, and contractors. Total capital cost allocated for detecting activities is 51,698,055,375

VND (around 2,485,125 USD in 2011) for PPM, and 43,354,887,407 VND (around 2,084,069 USD in 2011) for the system which is assumed that there are only public sectors involved in TB program.

The labor costs of these activities are including the allocated opportunity cost estimated through shadow salaries of medical doctors, medical doctor assistants, nurses, lab technicians, pharmaceutical workers, and other healthcare workers used, allocated for treating activities in district level, communal level of public TB system, and contractors. In addition, there is a kind of bonus money for those where TB patients treated successfully. Amount of this bonus was calculated from total number of success. Total labor cost allocated for treating activities is 5,593,739,473 VND (around 268,891 USD in 2011) for PPM, and 3,831,683,767 VND (around 184,189 USD in 2011) for the previous TB system.

The material costs of treatment are including drugs, chemistries, and medical supplies costs incurred by provincial level, as well as 2% allocated fuel costs for importing drugs, chemistries and medical supplies to district level. Total material cost of treating activities is 20,819,496,779 VND (around 1,000,793 USD in 2011) for PPM, and 11,637,073,382 VND (around 559,394 USD in 2011) for the previous TB system.

The allocation criterions are summarized in the Table 5.13 below.

Table 5.13. Allocation criterion capital costs for treating activities

<table>
<tr><th></th><th>Provincial</th><th>District</th><th>Communal</th><th>Contractors</th></tr>
<tr><td>Capital costs</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Examination rooms</td><td>20%</td><td>30%</td><td>N/A</td><td>40%-100%</td></tr>
<tr><td>Laboratories</td><td>10%</td><td>20%</td><td>N/A</td><td>40%-100%</td></tr>
<tr><td>DOTS rooms</td><td>0%</td><td>70%</td><td>80%</td><td>100%</td></tr>
<tr><td>Drug stores</td><td>75%</td><td>50%</td><td>70%</td><td>65%</td></tr>
<tr><td>Microscopes</td><td>0%</td><td>30%</td><td>N/A</td><td>30%</td></tr>
<tr><td>Biological safety cabinets</td><td>0%</td><td>30%</td><td>N/A</td><td>30%</td></tr>
<tr><td>Labor costs</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Medical doctors</td><td rowspan="6">0%</td><td>30%</td><td rowspan="6">30%</td><td>40%-100%</td></tr>
<tr><td>Medical doctor assistants</td><td>30%</td><td>40%-100%</td></tr>
<tr><td>Nurses</td><td>30%</td><td>40%-100%</td></tr>
<tr><td>Lab technicians</td><td>30%</td><td>40%-100%</td></tr>
<tr><td>Pharmacist assistants</td><td>60%</td><td>60%-100%</td></tr>
<tr><td>Others</td><td>30%</td><td>40%-100%</td></tr>
</table>

N/A: Not applicable

5.3.7. Summary

Table 5.14. Summary of Activity cost components in TB program for PPM

Activities	Capital costs	Labor costs	Material costs	Total
Administration	889,523	77,115	1,619	968,257
Monitoring	263,023	86,208	1,846	351,077
IC, ACSM, training, and researching	291,832	284,279	5,215	581,326
Screening suspects	652,521	434,748	1,769	1,089,038
Detecting	770,081	57,135	62,026	889,242
Treating	2,485,125	268,891	1,000,793	3,754,809
Total	5,352,105	1,208,376	1,073,268	**7,633,749**

Table 5.15. Summary of Activity cost components in TB program for the previous TB system

Activities	Capital costs	Labor costs	Material costs	Total
Administration	889,523	77,115	1,619	968,257
Monitoring	263,023	86,208	1,846	351,077
IC, ACSM, training, and researching	291,832	284,279	5,215	581,326
Screening suspects	458,239	93,684	1,769	553,692
Detecting	596,927	46,934	38,804	682,665
Treating	2,084,069	184,189	559,394	2,827,652
Total	4,583,613	772,409	608,647	**5,964,669**

Basing on the assumption, all costs incurred in PPM and the assumed previous TB system by the same hypothetical TB patients estimated from the TB prevalence in the year 2011. The Table 5.14 above and Table 5.15 above are summarizing all costs components, allocating for each activity, and separating for PPM and estimating for public only with the assumption there were only public sector involved in TB system in 2011. Total cost of TB program for PPM is 7,633,749 USD, and 5,936,142 USD for the previous TB system in which there are only public sectors involved in the year 2011.

5.4. Measuring effectiveness

5.4.1. Outcome summary

The Table 5.16 below is summarizing all number of cases categorized into five following categories:

- Number of sputum test through the number of tested sputum smears with two kind of results, including AFB+ and AFB- for detection and monitoring during TB treatments;
- Number of screened suspects with their determined diagnosis, including number of detected AFB+ TB patients, number of suspects with AFB- sputum test results. This number of suspects with AFB-sputum test results is not separated for no TB screened suspect, pulmonary AFB- TB patients, and extra pulmonary TB patients;
- Number of patients who registered for TB treatment categorized into all historical types and bacterial types of TB patients, excluding TB patients transferred from other provinces or private sector non-contracted under NTP, which were also reported as "transferred in" separately; and
- Number of followed, treated and lost patients. Lost patients are those who could not have contacted to during treatment.

Table 5.16. Outcome summary of TB program in Ho Chi Minh City in 2011

			PPM	Public only
Sputum test (Number of smears)	For detection	AFB+	21,279	17,129
		AFB-	150,619	90,175
	For treatment	AFB+	4,200	2,893
		AFB-	59,302	40,602
Screened suspects		AFB+	9,593	6,822
		AFB-	59,499	31,343
Registered patients	New PTB AFB+		7,444	4,380
	PTB AFB+ Retreated after relapsed		1,580	1,470
	PTB AFB+ Retreated after failure		282	267
	PTB AFB+ Retreated after defaulted		132	115
	Others PTB AFB+		303	296
	New PTB AFB-		3,451	1,203
	New EPTB		3,424	1,360
	Other AFB-, EPTB		553	232
Transfer in			743	706
Treated patients			17,105	8593
Lost			64	31
Treatment outcome	Cured		7,530	4,850
	Complete treatment		6,436	2,502
	Dead		584	304
	Failed treatment		548	328
	Defaulted		656	299
	Transferred out		1,351	309

5.4.2. Detection and treatment

According to WHO's Global Report for TB burden in 2011, published in 2012, the estimates TB prevalence, incidence, and mortality rate caused by TB in 2011 in Vietnam were estimated at 0.323% (ranged from 0.148% to 0.563%), 0.199% (ranged from 0.153% to 0.250%), and 0.033% (ranged from 0.014% to 0.062%) in population, respectively (WHO, 2012a). Applying these rates on 7,311,961 total population of Ho Chi Minh City, all TB cases estimated at 23,617 cases (ranged from 10,822 to 41,166 cases), the new infected TB patients estimated at 14,551 cases (ranged from 11,187 to 18,279 cases),and deaths caused by TB estimated at 2,412 cases (ranged from 1,024 to 4,533 cases). Due to the highest population and population density of Ho Chi Minh City, the higher estimated frequencies and probabilities above would be referred to be applied for estimating the effectiveness of TB program in term of detection and treatment.

Table 5.17. Summary of effectiveness of TB program in terms of detection and treatment

	PPM		**Public only**	
	Frequency	**Probability**	**Frequency**	**Probability**
Estimated TB patient in 2011	41,166		41,166	
Estimated new TB cases in 2011	18,279		18,279	
In TB population				
Detected cases	17,169	41.71%	9,260	22.49%
Undetected cases	23,997	58.29%	31,906	77.51%
Treated TB patients	17,105	41.55%	9,232	22.43%
Untreated cases	24,061	58.45%	31,934	77.57%
In detected cases				
Treated TB patients	17,105	99.63%	9,232	99.70%
Untreated cases	64	0.37%	28	0.30%
In treated cases				
Successful treatment	13,966	81.65%	7,601	82.34%
Unsuccessful treatment	3,139	18.355%	1,631	17.66%
Dead	584	3.42%	381	4.12%
Alive	16,521	96.59%	8,851	95.88%
In untreated cases				
Dead	3,949	16.41%	4,153	13.00%
Alive	20,112	83.59%	27,782	87.00%
In undetected cases				
Dead	3,939	16.41%	4,149	13.00%
Alive	20,058	83.59%	27,757	87.00%
In detected untreated cases				
Dead	11	16.41%	4	13.00%
Alive	53	83.59%	24	87.00%
In new infected cases				
Detected	14,319	98.41%	7,407	40.52%

The estimated effectiveness of TB program in term of detection and treatment is summarizing in Table 5.17 above. The detection rates in PPM and in the previous TB system 41.71% and 22.49%, respectively, in total number of TB patients in population. The treated rates in PPM and in the system which is assumed that there are only public sectors involved in TB program are 41.55% and 22.43%, respectively, in total number of TB patients in population. Among estimated newly infected TB cases, the newly infected TB detection rate was also increased from 40.52% in the previous TB system to 98.41% in PPM. The treated rates in detected TB patients from PPM and from the system which is assumed that there are only public sectors involved in TB program are 99.63% and 99.69%, respectively. Among TB patients who were treated, the success treatments, including cured cases and completed treatments, contributed 81.65% in PPM, and 85.56% in the system which is assumed that there are only public sectors involved in TB program. Deaths rates caused by TB among treated cases from PPM and from the system which is assumed that there are only public sectors involved in TB program are 3.41% and 3.54%, respectively.

The frequencies and probabilities of detected cases and treated cases from PPM among all TB patients showed in Table 5.17 above are higher than from the previous TB system. PPM is significantly increasing detection and treated rates in all TB population, as well as in newly infected TB patients, around two times compared with the previous TB system.

5.4.3. Dead averted and Life-year saved

Basing on outcome of TB program and patient's data analysis, the probabilities patients of age groups with each kind of outcome in each type of TB patients would be used for estimating the life-years saved. In order to measure the effectiveness of TB program in the year 2011 in term of life year saved caused by death averted, the assumption that all non-death treated TB patients will alive until the end their life expectancy estimated for the age group they belonging to is acceptable and suitable to use. The life year saved would be calculated by multiplying the number of non-death treated TB patients of each age group by the life expectancy, respectively, estimated by WHO in 2009. Total life years saved of each kind of treatment outcomes are summarized in Table 5.18 below.

Table 5.18. Summary of Life-years saved of each kind of outcome

	PPM	Public only
Cured patients	280,506	178,355
Completed treatments	264,053	112,833
Failed treatments	19,732	10,508
Defaulted treatments	25,485	11,485
Patients who were transferred out	52,535	22,958
Total LYG	642,311	336,139
Average LYG	39	38

PPM implemented was really effect on reducing life-years lost caused by death of TB patients. Assuming that there was no death among treated TB patients, total life expectancy would be 661,666 life-years in PPM, and in the previous TB system would be estimated at 349,377 life-years. Total life-years lost caused by death of TB patients in PPM was 19,355 life-years (contributed 2.93% in total life expectancy if there were no death in treated TB patients), and for the previous TB system was estimated at 13,238 life-years (contributed 3.79% in total life expectancy if there were no death in treated TB patients). Obviously, TB program was reducing 96.21% life-years lost caused by death of TB patients in the previous TB system, and 97.07% in PPM. PPM implemented was reducing 0.86% of life-years lost comparing with the previous TB system.

5.5. Cost-effectiveness analysis

5.5.1. Average costs and unit costs per screened suspects, detected TB patients, treated TB patients

Average cost per each type of TB program's outcomes showed in Table 5.19 below would be calculated by dividing respective cost by the respective number of each type of outcomes. Unit cost of each activity showed in Table 5.20 below would be calculated by dividing the direct cost of each activity by each respective outcome.

Table 5.19. Average cost per each type of outcome (USD in 2011)

Average cost of	PPM		Public only*	
	No.	Cost	No.	Cost
TB patients	41,166	185.44	41,166	144.89
Screened suspects	69,092	110.49	38,165	103.21
Detected TB patients	17,169	444.62	8,620	644.13
Treated TB patients	17,105	446.29	8,593	646.09
Death adverted	16,521	462.06	8,851	673.90

**: Hypothetical estimation*

Table 5.20. Unit cost of each activity (USD in 2011)

Unit cost of	PPM		Public only*	
	No.	Cost	No.	Cost
Administrative activities' cost (calculated for each TB patient) *(including the administration, IC, ACSM, training, researching activities)*	41,166	46	41,166	46.17
Screening activities (calculated for each screened suspect)	69,092	16	38,165	9.58
Detecting activities (calculated for each detected TB patient)	17,169	52	8,620	73.72
Treating activities (calculated for each treated TB patient)	17,105	220	8,593	306.29

**: Hypothetical estimation*

5.5.2. Cost per life-year gained

Total cost per life-years gained in PPM system was 247,240 VND (around 11.8848 USD in 2011), and in the previous TB system was estimated at 369,142 VND (around 17.7447 USD in 2011).

5.6. Incremental cost-effectiveness analysis

Estimating the incremental cost-effectiveness basically based on two components. There are incremental cost and incremental effectiveness. Incremental cost when PPM was implemented is around 34,721,871,240 VND (around 1,669,080 USD in 2011). Incremental effectiveness in term of life-years gained when PPM are implemented is around 306,172 life-years, and in term of death adverted is 7,670 lives. Incremental cost-effectiveness ratio (ICER) in term of life-years gained is around 113,406 VND (around 5.4515 USD in 2011) per life-year gained, and in term of death adverted is 4,526,971 VND (around 217.61 USD in 2011).

5.7. Sensitivity analysis

5.7.1. Uncertainty

Assuming probabilities are distributed complying Beta distribution, costs and life-years gained are distributed complying Gamma distribution. The Table 5.21 below is summarizing the characteristics of parameters cause uncertainties.

Table 5.21. Summary of the characteristics of parameters cause uncertainties

Parameter	PPM			Public only		
Probability	**Base-case**	**Distribution**	**SE***	**Base case**	**Distribution**	**SE***
Detected cases / all TB patient	0.417	Beta	0.003	0.225	Beta	0.002
Treated / detected cases	0.996	Beta	0.001	0.997	Beta	0.001
Success / treated cases	0.816	Beta	0.003	0.823	Beta	0.004
Death / treated cases	0.034	Beta	0.001	0.041	Beta	0.002
Death / untreated cases	0.164	Beta	0.002	0.130	Beta	0.002
TB patients/ screened suspects	0.596	Beta	0.003	0.712	Beta	0.002
Costs	**Base-case**	**Distribution**	**SE****	**Base case**	**Distribution**	**SE****
UC of TB patient	46	Gamma	9	46.17	Gamma	9
UC of screened suspect	16	Gamma	3	9.58	Gamma	2
UC of detected TB patients	52	Gamma	10	73.72	Gamma	15
UC of treated TB patients	220	Gamma	44	306.29	Gamma	61
Life year gained	**Base-case**	**Distribution**	**SE****	**Base case**	**Distribution**	**SE****
Ave LYG	39	Gamma	7.780	37.98	Gamma	7.60

* : *Standard error (SE) of a probability (p) of a nominator divided by a denominator (n) distributed by Beta distribution is calculated through the equation that* $SE = \sqrt{\frac{p \times (1-p)}{n}}$

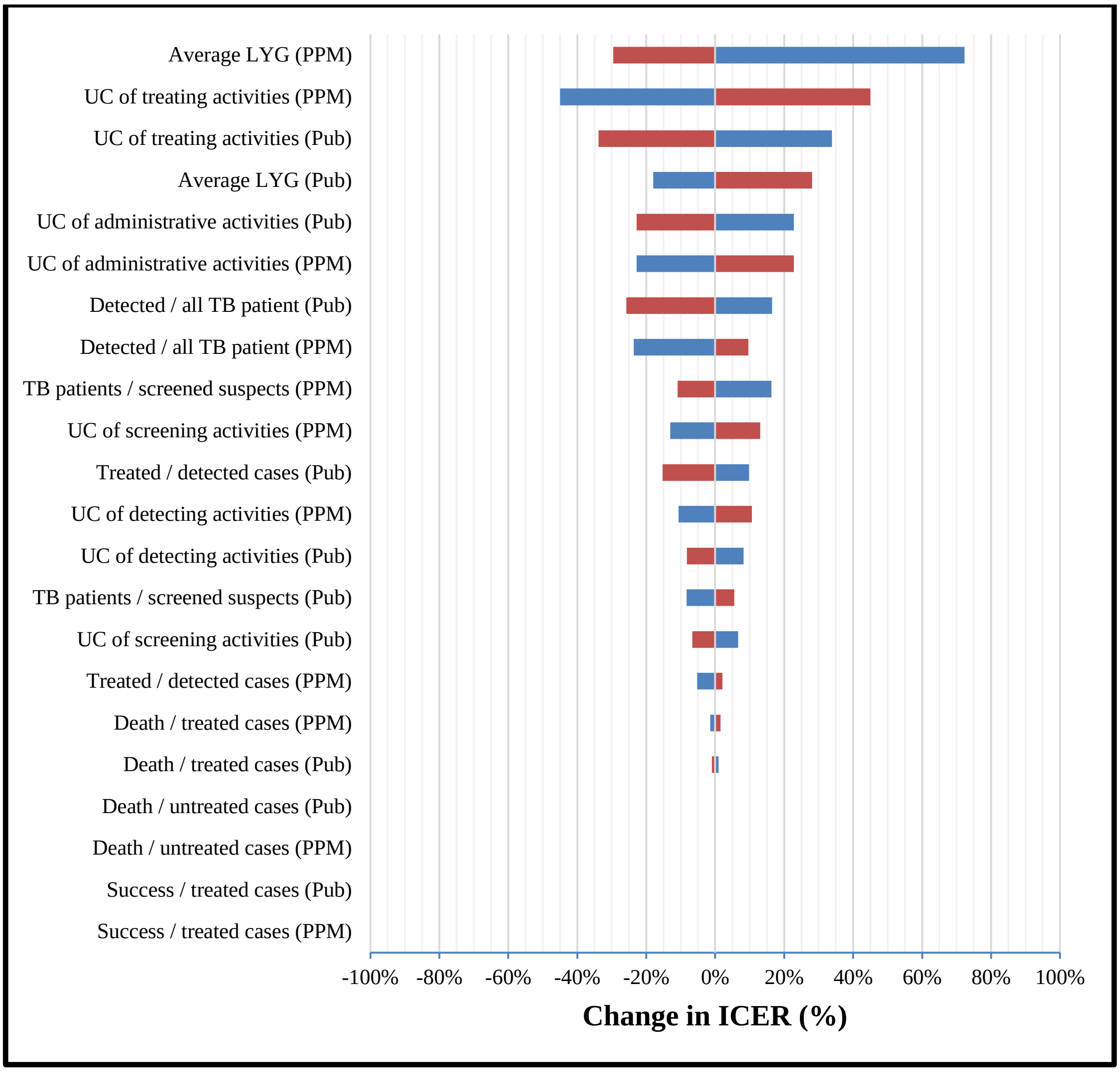
** : *Standard errors (SE) are calculated at 20% of the base-case value in the meaning that these parameters are varying from -20% to +20% of their original values.*

5.7.2. One-way sensitivity analysis and Tornado diagram

This study provided the simple One-way sensitivity analysis of the percentage change of ICER when each parameter changed from -20% to +20% of its original value under the base-case conditions.

The Figure 5.1 below is Tornado diagram representing the incremental cost-effectiveness ratios of one-way sensitivity analysis on the PPM compared to the previous TB system in which there are only public sectors were assumed to be involved in TB program in 2011. The vertical line represents the original estimated ICER under base-case conditions.

Figure 5.1. Tornado diagram for One-way sensitivity analysis of ICER when each parameter changed from -20% to +20% of its origin



According to the Figure 5.1 above, the highest level of the percentage change of ICER caused by the average life-year gained from PPM system. The other factors related to costs and epidemiological indicators also impacted on the percentage change of ICER at variable levels. It is meaning that the ICER of PPM system implementation is sensitive with these factors assuming that they will be change alone. Successful treatment rate and the death rate among untreated cases were insensitive to ICER. These impacts are summarizing in Table 5.22 below.

Table 5.22. Summary of ICER changing respected with the changes of each parameter from -20% to +20% of its origin

Parameter	PPM system				Previous TB system			
	ICER		% change		ICER		% change	
	-20%	20%	-20%	20%	-20%	20%	-20%	20%
Death / treated cases	5.4	5.5	-1.46%	+1.51%	5.5	5.4	+0.95%	-0.94%
Treated / detected cases	5.2	5.6	-5.23%	+2.14%	6.0	4.6	+9. 8%	-15.3%
UC of screening activities	4.7	6.2	-13.1%	+13.1%	5.8	5.1	+6.64%	-6.64%
TB patients / screened suspects	6.3	4.9	+16.3%	-10.9%	5.0	5.8	-8.29%	+5.53%
UC of detecting activities	4.9	6.0	-10.7%	+10.7%	5.9	5.0	+8.2%	-8.2%
Detected / all TB patient	**4.2**	**6.0**	**-23.6%**	**+9.6%**	**6.4**	**4.1**	**+16.5%**	**-25.8%**
UC of administrative activities	**4.2**	**6.7**	**-22.8%**	**+22.8%**	**6.7**	**4.2**	**+22.8%**	**-22.8%**
UC of treating activities	**3.0**	**8.0**	**-45%**	**+45%**	**7.3**	**3.6**	**+33.9%**	**-33.9%**
Average LYG	**9.4**	**3.8**	**+72.3%**	**-29.6%**	**4.5**	**7.0**	**-18%**	**+28.1%**

5.7.3. Probabilistic sensitivity analysis

Applying the information provided in Table 5.21, the probabilistic sensitivity analysis was basing on thousands repeated randomly selections of all parameters' value from their ranges complying on their distribution, and the ICERs plotting on the Figure 5.2 below as the outputs. At the percentiles less than 8.6%, the ICERs were less than 0. The mean, standard deviation, median, percentiles of ICERs are summarized in Table 5.23 below. According to the Table 5.23 and the Figure 5.2, the PPM system was sensitive to ICER and this study's results are proven be robust.

Figure 5.2. Scatter Plots for Probabilistic sensitivity analysis

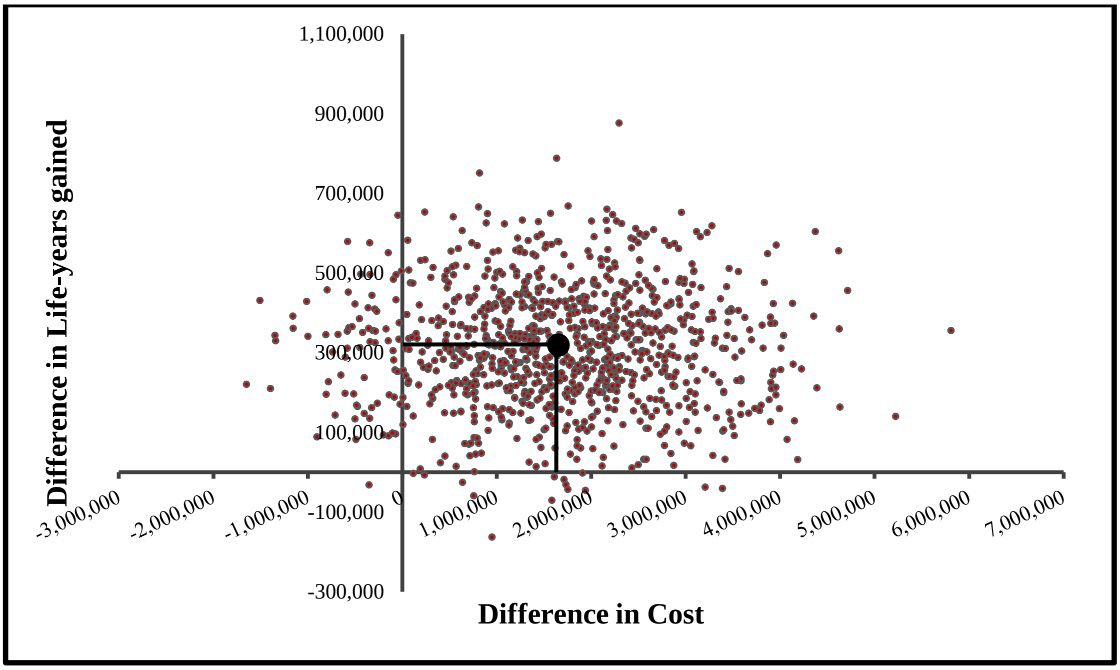


Table 5.23. Statistical summary of ICER in Probabilistic sensitivity analysis

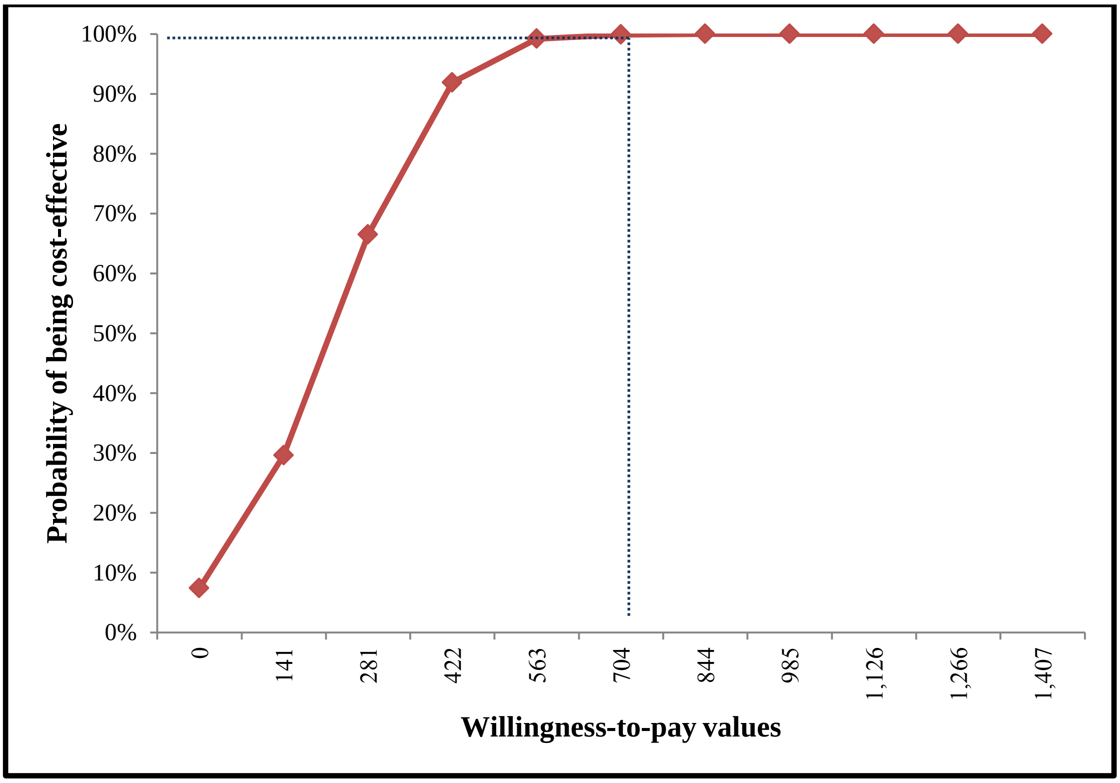
	ICER in term of life-years gained			
Deterministic	5.4515			
Probabilistic	**Mean**	7.1550	**Median**	5.2104
	SD	46.1541		
	2.5%	-3.1992	**75%**	+8.6710
	5%	-1.4286	**90%**	+15.3218
	10%	+0.3019	**95%**	+23.4126
	25%	+2.7096	**97.5%**	+33.9883

5.7.4. Cost-effectiveness acceptability

Table 5.24. Probability of being cost-effective respected with the willingness to pay

WTP values	Probability of being cost-effective	WTP values	Probability of being cost-effective	WTP values	Probability of being cost-effective
0	7%	563	99%	1,126	100%
141	30%	**704**	**100%**	1,266	100%
281	67%	844	100%	**1,407**	**100%**
422	92%	985	100%		

Figure 5.3. Cost-effectiveness acceptability curve



According to the Figure 5.3 and Table 5.24 above, the CEAC showed that PPM system can be perfectly cost effective at an ICER (in term of deaths averted) Threshold of 704 USD in the year 2011, which was equal a half of a GDP per capita (1,407 USD in 2011).

CHAPTER VI
DISCUSSION

6.1. Characteristic of TB patients in Ho Chi Minh City in 2011

Proportion of male patients was equal 2.3 times compared with female patients. It is reasonable because of Vietnamese culture, in which males are riskier than females to be infected by TB due to high-risk behavior, such as smoking, etc. The average age of TB patients was around 40 years-old. It is also reasonable and explainable basing on epidemiological theory of TB because. TB is a communicable disease, spreading out through the air, so that these age groups are risky to get TB due to they are the groups who have more communication then the others.

The highest proportion of TB patients was the liberal occupation made common sense because this occupational group is variety combination of many jobs, but the most important reason explains for this high proportion is their vary workplace and communicability. In this group, they could be freely cleaners, constructors, self-employers, etc., who had muscle job, and have communicated to vary people daily, and of course, they were high risked to get TB.

The proportion of AFB+ PTB patients was higher than AFB- PTB and EPTB. It is appropriate with the specifics of TB disease, which mostly infects on lungs with positive bacteria available in patients' sputum. This proportion reflected that the TB burden Vietnam, specifically in Ho Chi Minh City, caused mostly by the newly infected TB patients, and the TB incidence might be quite high.

6.2. Costs

Comparing the costs of activities, different activities contributed different level into the total cost of TB program. In both PPM and the previous TB system with public sectors only, the cost of treating activities is the highest compared with the others. It is apparent because the cost of treating activities was including the drugs cost, which are the highest explicit cost components in accurate diseases. Thus, the treating cost itself contributed around 50% of total cost of TB program whether PPM implemented, or not.

While the cost of administration, monitoring, IC, ACSM, training, and researching activities were not different, the contribution of other cost components were completely different compared between PPM and the previous TB system. The PPM implemented was significantly increasing the cost of screening activities, especially in labor cost, and particularly increasing the cost of detecting activities. It is reasonable because PPM, initially, implemented focusing on the first model, in which the suspects would be screened mostly, and sometimes be detected, in contractors, and then, be referred to public TB system. Obviously, the cost of screening would be increased caused by pushing the screening and detecting activities through.

In the other hand, the cost of administration, monitoring, IC, ACSM, training, and researching activities should increasing when PPM implemented due to involving private sector for expanding and up-scaling the TB program, However, they were remaining the same with the previous TB system leading to be unreasonable. Because NTP in Ho Chi Minh City is still lacking in human resources and budget allocated for TB program, NTP and government had not allocated and transacted any specific amount for these activities to the contractors. These costs of the contractors were incurred by themselves. Even though these cost components contributed big amounts, the increases of them when PPM system implemented are predictably not quite significantly high because the PPM system built up focusing on increasing clinical benefits. Although, this should be considered as a limitation also.

Comparing the type of cost components, each type of cost contributed differently in total cost. The capital costs of treating activities are always the highest components. According to the DOTS strategy for TB treatment, TB patients will be treated and directly observed based on community. However, due to the limited human resources, DOTS applying in Ho Chi Minh City is basing on healthcare worker at healthcare facilities. It caused the capital cost of treatment faced by health system increasing as that much.

6.3. Effectiveness

While there is huge difference of detection rate between PPM and the previous TB system, the treated rate among detected patients and the successfully treated rate among treated patient were not significantly different. PPM has been implemented in

Ho Chi Minh City since 2009, initially, mostly based on the first model in which the TB suspects would be referred to public TB system after being symptom screened in contractors. That means PPM in the year 2011 was focusing on screening and detecting activity, so that under PPM, TB program tried to detect as much as possible by contracting with private sector and some public hospitals, which are not belong to TB system. Under that model, the chance of a TB patient to be detected earlier, and correctly, was significantly increasing compared with the system before PPM. Otherwise, there is no new drug or treatment technique applied when PPM implemented.

This study's results showed that PPM was significantly increasing the detection rate from 22.49% to 41.79% among estimated TB population. Among estimated newly infected TB cases, detection rate was also increased from 40.52% in the previous TB system to 98.41% in PPM. This result is similar with the conclusion of author Xu et. al. published in 2002 (Xu et al., 2002), and author R. Baltussen et. al. published in 2005(R. Baltussen et al., 2005). The effectiveness of PPM, especially in the first model, is increasing detection rate, similar with previous articles (Ardian et al., 2007; Arora et al., 2004; Balasubramanian et al., 2006; Kumar et al., 2005).

Whether PPM was implemented, DOTS in TB program was reducing life-years lost in treated TB patients at the higher rate than some other countries. While DOTS reduced 89.19% of life-years lost in Beijing, China (Xu et al., 2002), this rate in DOTS in TB program in Ho Chi Minh City, Vietnam was 96.21%, and increased 0.86% when PPM implemented. However, with very small increasing rate when PPM implemented, it is not very strongly convinced that PPM was significantly reducing life-years lost in treated TB patients comparing with the previous TB system.

In the other hand, to evaluate the effectiveness of TB program for those who have HIV is so complicated. The TB patients who got HIV have high dead rate, and their life expectancy is completely lower than the other kinds. Otherwise, their deaths were also caused by many factors, not only TB. However, the proportion of TB patients with HIV among registered TB patients is quite low, and the way to treat them is not quite different from other kind of TB patient according to the NTP's guidelines (NTP, 2009), so that cost of their treatment might not be effected by their HIV status. Due to their very low proportion among registered TB patient, this study can assume that these TB related HIV patients were similar with the other kind of TB patients with tiny bias but acceptable.

6.4. Cost-effectiveness

TB program in both systems was proved that it was a cost effective intervention. According to the cost-effectiveness ratio, the average cost and additional cost of all type of TB program's outcomes were less than the GDP per capita of Vietnam, which was reported by World Bank at 1,407 USD per capita in the year 2011 (The World Bank, 2013). It is meaning that TB program was not only have clinical and epidemiological effectiveness through providing TB treatments, adverting deaths caused by TB, but also have the economic impacts that using the smaller cost for successfully treating and adverting deaths, getting higher saving. However, this statement is not so strong because this study did not include the cost incurred by patient and productivities lost caused by treatment process for supporting. It is necessary to conduct another study, or expand this study, focusing on the patients' costs and productivities lost caused by TB treatment.

With different setting in different context, as well as the different cost components included in this study, it will be very incommensurate if the result of this study is compared with other studies from other countries. Even though, there was not cost-effectiveness of TB program conducted specifying for Ho Chi Minh City in Vietnam. This study can be the base-line for conducting other economic evaluation researches later on.

6.5. Incremental cost-effectiveness

The additional cost for PPM implementation to get one more life-year gained is quite low. On the scatter plots diagram of difference in cost and difference in life-years gained, this ICER was plotted on the first quarter. That means PPM implementation leads more cost respecting with more effective.

6.6. Sensitivity analysis

The One-way sensitivity analysis and probabilistic sensitivity analysis proved that the ICER result of this study is robust due to the narrow variability of ICER even when some uncertainties lead the parameters changed.

6.7. Limitation of study

The widest limitation of this study is caused by the previous TB system, which one is no longer available. Since 2009, TB program in Ho Chi Minh City has officially implemented the PPM system, in which the private sector contracts with the public sector to provide TB treatment, substituted for the conventional system, in which TB treatments were provided by public sector under NTP only. This study aims to compare cost-effectiveness of PPM system to the previous TB system based on the assumption that the previous TB system is still exist in 2011. However, because the data for costing and measuring effectiveness can be relatively separated for those models, this study result could be acceptable. Besides, in the sense of sustaining PPM system when the external funds will be withdrawn, this study is essential particularly contributing to the further study for assessing the budget impacts of PPM. Even though, this limitation should be considered.

The epidemiological indicators used in this study, such as TB prevalence, incidence, mortality rate caused by TB in Ho Chi Minh City in 2011, caused a limitation. These indicators were assumed to be similar with WHO's Global Report for the year 2011, published in 2012. However, because of the specifics of Ho Chi Minh City, the TB prevalence of Ho Chi Minh City could be higher than the estimate of WHO for whole nation, and the mortality rate caused by TB might higher caused by higher prevalence, or lower caused by good condition for treatment.

Another limitation caused by a list of three assumptions built for this study. (1) All TB patients were assumed to seek and to be involved in screening process. However, this is the largest uncertainty that this study could not cover because no evidence from epidemiological survey proved for that statement; (2) All the TB patients were assumed to be registered immediately when they were detected as the Vietnamese National TB management guideline. However, during the referral process, especially from private sector to TB system, there are some lost cases which the TB system had no chance to control; (3) All TB patients dying during TB treatment were assumed caused by TB, not because of other diseases. However, there was a small proportion of TB patients were dying during TB treatment but caused by other diseases, especially in TB/HIV cases. In fact, it is impossible to improve these limitations with the lacking information system as Vietnam has.

This research is very specific in the context only one city with its own characteristics, so that the results may be comprehensive because of the vary activities and the strength of Ho Chi Minh City, but may not be able to generalize for TB program in the whole nation. For applying this result in other provinces' context, adjustment is essential in each specific context.

Besides, the MDR treatment have just involved in TB program since 2009 for officially providing free treatment for MDR patients in Ho Chi Minh City. However, the outcomes of MDR treatment would have comprehensively reported after two years from the date when the patients registered due to long treatment duration. Up now, the MDR patients registered in 2011 have not treated enough time for assessing their treatment outcomes. This study would exclude costs and outcomes of MDR TB patients' treatment. It is one limitation of this study.

Another limitation of this study should be considered is effectiveness measurement specifying for Ho Chi Minh City in term of life years gained estimated from the Vietnamese life table. The life table built up for the whole country may not reflect exactly the life expectancy of the specific population of Ho Chi Minh City. Due to the unavailability of information, this study will be conducted based on the assumption that the life expectancy of the whole country can represent for people in Ho Chi Minh City. Although that is still a limitation of this study, but the result of this study has some certain value.

CHAPTER VII
CONCLUSION AND RECOMMENDATIONS

7.1. Conclusion

Public-private mixed system in Tuberculosis program is internationally recommended by World Health Organization to increase cooperation between public and private sector for effectively providing TB treatment. Although clinical benefits of PPM are apparent, the economic impacts of PPM are still unclear compared with the previous TB system, in which only public health system provided TB treatments following DOTS. This study aims to measure the cost-effectiveness of TB treatment and incremental cost-effectiveness in the PPM system compared to the previous TB system from a health system perspective under Vietnamese National TB Program in Ho Chi Minh City, Vietnam.

This study was done the cost-effectiveness analysis for PPM system in the NTP in Ho Chi Minh City in 2011 in the order to explore the cost-effectiveness of PPM system and the incremental cost-effectiveness of PPM implementation. A hypothesis was employed in this study that PPM implemented might be increasing the detection rate, treated rate, reducing the cost per outcome, and increasing cost effective of TB program in Ho Chi Minh City.

PPM system is containing four models: Model 1 (Referring suspects), Model 2 (Diagnosing), Model 3 (Treating), and Model 4 (Diagnosing and treating). Due to insufficient data available separately for each kind of PPM models, this study could not compare between those models. Instead, the "PPM system" using in this study is standing for the combination of all four models together.

This study collected a retrospective secondary data including the patients' data from medical records, Ho Chi Minh City TB Program's reports, and primary qualitative data from in-depth interviews and direct observations.

Cost-effectiveness study was conducted for the whole TB program in Ho Chi Minh City in the fiscal year 2011, applying the activity-based costing method, from the health system perspective. The activities involved in NTP are classified into six main activities: 1) Administration activities, 2) Monitoring activities, 3) Infection control (IC), Advocacy-Communication-Social Mobilization (ACSM), training, and researching activities, 4) Screening activities, 5) Detecting activities; and 6) Treating activities. The costs of the program will include related costs in all levels of health system and sub-system that involved in TB treatments under NTP. Capital costs, material costs and labor cost such as opportunity costs of used space, cost of equipment, salaries, etc. will be allocated by percentage used.

Outcomes of TB program under NTP were measured through detected patients, treated patients, successful treatment cases, and life-years gained (LYG) calculated from the remaining life expectancy using life table specifying for Vietnam.

Incremental costs-effectiveness analysis (ICEA) is estimating through dividing the different cost by the different effectiveness in term of life-yeas gained of PPM and the conventional TB system in which only public sectors were assumed to be involved.

Total cost of TB program for PPM was USD 7,633,749, higher than the previous TB system in which the total cost was estimated at USD 5,936,142 in the year 2011. PPM is significantly increasing suspect screened rate (from 57,793 suspects to 69,092 suspects), detection rate (from 22.49% to 41.71%), and treated rates (from 22.43% to 41.55%) in all TB population at 1% significance level. However, PPM was insignificantly increasing treated rate among detected TB patients (around 98%). Total life-years gained were also increased from 336,139 in the previous TB system to 642,311 in PPM system.

The capital cost of treating activities was still high while it should be lower. The DOTS should lead TB patients to be treated based on community. Reducing this cost is possible if the policy maker develop the DOTS system basing on home guardian as some previous researcher mentioned (Khan et al., 2002; Nieto et al., 2012; Prado et al., 2011).

TB program in both systems was proved that it was a cost effective intervention. The average costs of a TB patient and a screened suspect were around US$185.44 and US$ 110.49, respectively, in PPM system, higher than in the previous TB system in which they were hypothetically estimated around US$144.89 and US$103.21, respectively, in 2011. Inversely, the average costs of a detected, treated TB patient, adverted death, and successful treatment in PPM system were lower than the hypothetical estimation for the previous TB system, say US$444.62, US$446.29, US$462.06, US$547 comparing with the estimates of US$644.13, US$646.09, US$673.88, US$784.70, respectively. Total cost per life-years gained in PPM system was around 11.8848 USD.

The PPM system implemented lead TB program more cost-effective. Incremental cost-effectiveness ratio (ICER) was around 5.4515 USD per life-year gained in 2011 meaning that when PPM implemented, to get one more life-year gained, TB program had to pay around 5.4515 USD more in 2011.

The average cost per a screened suspect in PPM was slightly higher than in the previous system while the other kind of average costs were significantly reduced when PPM were implemented. TB program is cost effective, and PPM implemented lead TB program became more cost effective.

This study explored the average life-year gained had the greatest effect on the ICER. Successful treatment rate and the death rate among untreated cases were insensitive to ICER if they are varying alone. Generally, probability sensitivity analysis provided that the ICER was ranged from US$7.16 – US$46.15 to US$7.16 + US$46.15. ICERs were spread out from 10% percentile by US$0.3 to 90% percentile by US$15.3 with the median was US$5.21 proven for the robustness of this study's results.

The cost-effectiveness acceptability analysis showed that TB program can reach 100% being cost effective if the willingness to pay is at least US$704, which is equal to a half of GDP per capita. This finding can be very useful information for policy maker considering in budget planning.

PPM system implemented initially focusing on the first model which known as "referring model" leading to the reasonable increase of the screened rate, detection rate, and the screening cost. The first model of PPM is strongly proved that it leads to many advantages and improve obviously effectiveness of TB program. This model should be sustained, or even expanded.

Although PPM was significantly increasing detection rate, the treated and successful treatment rates were not increased. Obviously, in order to improve effectiveness of PPM, policy makers should expand not only the first model, but also the other models. TB program should try to encourage and support for contractors, improve their capability, so that they can meet the requirement for contracting the other advance models. In that condition, expecting for more effectiveness in treating activities is visible.

Although some of limitations are impossible to avoid, such as the limitation caused by the unavailable previous TB system, etc., there are some of limitation can be avoided. Done an epidemiological survey for getting the real epidemiological indicator can avoid many limitations caused by the list of assumptions this study used the assumed information from global reports or national estimates instead of the real ones specified for Ho Chi Minh City. It will lead the result be more precise. In addition, TB system in Vietnam should also improve the information and referral system for the purpose to control and manage TB patient thoroughly, as well as avoiding losing TB patients.

7.2. Recommendation

According to the findings of this study, the following recommendations can be made for policy maker in order to improve TB program in Ho Chi Minh City, or even on national wide.

- Develop the DOTS system basing on home guardian;
- Sustaining and expanding the model 1 of PPM system focusing on referring TB suspects;
- Encourage and support for contractors, improve their capability, so that they can meet the requirement for contracting the other advance models;
- Apply the cost-effectiveness acceptability analysis for budget planning;
- Conduct the routinely epidemiological survey to collect the real epidemiological indicators;
- Improve the information system and referral system thoroughly.

REFERENCES

Ardian, M., Meokbun, E., Siburian, L., Malonda, E., Waramori, G., Penttinen, P., . . . Kelly, P. M. (2007). A public-private partnership for TB control in Timika, Papua Province, Indonesia. Int J Tuberc Lung Dis, 11, 10: 1101-1107.

Arora, V. K., Lonnroth, K., & Sarin, R. (2004). Improved case detection of tuberculosis through a public-private partnership. Indian J Chest Dis Allied Sci, 46, 2: 133-136.

Baker, J. D. (1998). Activity-based costing and activity-based management for health care. Aspen Publishers, Gaithersburg, Maryland.

Balasubramanian, R., Rajeswari, R., Vijayabhaskara, R. D., Jaggarajamma, K., Gopi, P. G., Chandrasekaran, V., & Narayanan, P. R. (2006). A rural public-private partnership model in tuberculosis control in south India. Int J Tuberc Lung Dis, 10, 12: 1380-1385.

Baltussen, R., Floyd, K., & Dye, C. (2005). Cost effectiveness analysis of strategies for tuberculosis control in developing countries. BMJ, 331, 7529: 1364. doi: 10.1136/bmj.38645.660093.68

Baltussen, R. M., Hutubessy, R. C., Evans, D. B., & Murray, C. J. (2002). Uncertainty in cost-effectiveness analysis. Probabilistic uncertainty analysis and stochastic league tables. International journal of technology assessment in health care, 18, 1: 112-119.

Bambha, K., & Kim, W. R. (2004). Cost-effectiveness analysis and incremental cost-effectiveness ratios: uses and pitfalls. Eur J Gastroenterol Hepatol, 16, 6: 519-526.

Barlow, W. E. (2009). Overview of methods to estimate the medical costs of cancer. Med Care, 47, 7 Suppl 1: S33-36. doi: 10.1097/MLR.0b013e3181a2d847

Brazier, J., Ratcliffe, J., Salomon, J. A., & Tsuchiya, A. (2007). Measuring and Valuing Health Benefits for Economic Evaluation: Oxford University Press.

Buu, T. N., van Soolingen, D., Huyen, M. N., Lan, N. T., Quy, H. T., Tiemersma, E. W., . . . Cobelens, F. G. (2012). Increased transmission of Mycobacterium tuberculosis Beijing genotype strains associated with resistance to streptomycin: a population-based study. PLoS One, 7, 8: e42323. doi: 10.1371/journal.pone.0042323

Cantor, Scott B., & Ganiats, Theodore G. (1999). Incremental Cost-Effectiveness Analysis: The Optimal Strategy Depends on the Strategy Set. Journal of Clinical Epidemiology, 52, 6: 517-522. doi: http://dx.doi.org/10.1016/S0895-4356(99)00021-9

Creese, A., & Parker, D. C. (1994). Cost analysis in primary health care: a training manual for programme managers (ed.). Geneva: World Health Organization.

Dang, D. M. (2011). Public-Private mixed under Tuberculosis program in Ho Chi Minh City. 2011, available from: http://www.medinet.hochiminhcity.gov.vn/data/news/2011/3/7939/phoihop.htm

Dang, D. M. (2012). Public-Private Mixed under Tuberculosis program in Ho Chi Minh City. In NTP (Ed.), Lauch to free TB Vietnam (pp. 16). Ho Chi Minh City: National Tuberculosis Program of Vietnam

Pham Ngoc Thach Tuberculosis and Lung Diseases Hospital.

Datiko, D. G., & Lindtjorn, B. (2010). Cost and cost-effectiveness of smear-positive tuberculosis treatment by Health Extension Workers in Southern Ethiopia: a community randomized trial. PLoS One, 5, 2: e9158. doi: 10.1371/journal.pone.0009158

Drummond, M. F., & Jefferson, T. O. (1996). Guidelines for authors and peer reviewers of economic submissions to the BMJ. The BMJ Economic Evaluation Working Party. BMJ, 313, 7052: 275-283.

Drummond, M. F., Sculpher, M. J., Torrance, G. W., O'Brien, B. J., & Stoddart, G. L. (2007). Basic types of economic evaluation Methods for the Economic Evaluation of Health Care Programmes (3 ed.): Oxford University Press.

Drummond, M. F., Stoddart, G., & Torrance, G. (2005). Methods for the Economic Evaluation of Health Care Programmes (3 ed.). New York: Oxford University Press Inc.

Eichler, Hans-Georg, Kong, Sheldon X., Gerth, William C., Mavros, Panagiotis, & Jönsson, Bengt. (2004). Use of Cost-Effectiveness Analysis in Health-Care Resource Allocation Decision-Making: How Are Cost-Effectiveness Thresholds Expected to Emerge? Value in Health, 7, 5: 518-528. doi: http://dx.doi.org/10.1111/j.1524-4733.2004.75003.x

Fitzpatrick, C., & Floyd, K. (2012). A systematic review of the cost and cost effectiveness of treatment for multidrug-resistant tuberculosis. Pharmacoeconomics, 30, 1: 63-80. doi: 10.2165/11595340-000000000-00000

Floyd, K., Arora, V. K., Murthy, K. J., Lonnroth, K., Singla, N., Akbar, Y., . . . Uplekar, M. (2006). Cost and cost-effectiveness of PPM-DOTS for tuberculosis control: evidence from India. Bull World Health Organ, 84, 6: 437-445. doi: /S0042-96862006000600012

GSO. (2011). Area, population and population density distribution in localities.

Jacobs, P.; Shanahan, M.; Roos, N.P., Farnworth, M. (1999). Cost List for Manitoba Health Services.

Jain, R., Grabner, M., & Onukwugha, E. (2011). Sensitivity analysis in cost-effectiveness studies: from guidelines to practice. Pharmacoeconomics, 29, 4: 297-314. doi: 10.2165/11584630-000000000-00000

Johannesson, M. (1996). Theory and methods of economic evaluation of health care. Dev Health Econ Public Policy, 4: 1-245.

Kamolratanakul, P., Hiransuthikul, N., Singhadong, N., Kasetjaroen, Y., Akksilp, S., & Lertmaharit, S. (2002). Cost analysis of different types of tuberculosis patient at tuberculosis centers in Thailand. The Southeast Asian journal of tropical medicine and public health, 33, 2: 321-330.

Khan, M. A., Walley, J. D., Witter, S. N., Imran, A., & Safdar, N. (2002). Costs and cost-effectiveness of different DOT strategies for the treatment of tuberculosis in Pakistan. Directly Observed Treatment. Health Policy Plan, 17, 2: 178-186.

Kumar, M. K., Dewan, P. K., Nair, P. K., Frieden, T. R., Sahu, S., Wares, F., . . . Chauhan, L. S. (2005). Improved tuberculosis case detection through public-private partnership and laboratory-based surveillance, Kannur District, Kerala, India, 2001-2002. Int J Tuberc Lung Dis, 9, 8: 870-876.

Kumaranayake, L., & Watts, C. (2000). Economic costs of HIV/AIDS prevention activities in sub-Saharan Africa. AIDS, 14 Suppl 3: S239-252.

Levin, Henry M., & McEwan, Patrick J. (2000). International Handbook of Educational Evaluation: Cost-effectiveness analysis as an evaluation tool (ed.): Teachers College, Columbia University, Wellesley College.

Lipscomb, J., Yabroff, R. K., Brown, M. L. , Lawrence, W., & Barnett, P. G. (2009). Health care costing: data, methods, current applications. Medical care, 47, 7: S1-6.

Manabe, Y. C., Hermans, S. M., Lamorde, M., Castelnuovo, B., Mullins, C. D., & Kuznik, A. (2012). Rifampicin for continuation phase tuberculosis treatment in Uganda: a cost-effectiveness analysis. PloS one, 7, 6: e39187. doi: 10.1371/journal.pone.0039187

Moalosi, G., Floyd, K., Phatshwane, J., Moeti, T., Binkin, N., & Kenyon, T. (2003). Cost-effectiveness of home-based care versus hospital care for chronically ill tuberculosis patients, Francistown, Botswana. Int J Tuberc Lung Dis, 7, 9 Suppl 1: S80-85.

Muennig, Peter. (2008). Cost-effectiveness analyses in health : a practical approach (2 ed.). San Francisco: Jossey-Bass.

Murray, C. J., Evans, D. B., Acharya, A., & Baltussen, R. M. (2000). Development of WHO guidelines on generalized cost-effectiveness analysis. Health Econ, 9, 3: 235-251.

Muto, H., Tani, Y., Suzuki, S., Yokooka, Y., Abe, T., Sase, Y., . . . Ogasawara, K. (2011). Filmless versus film-based systems in radiographic examination costs: an activity-based costing method. BMC Health Serv Res, 11: 246. doi: 10.1186/1472-6963-11-246

Neumann, P. J. (2009). Costing and perspective in published cost-effectiveness analysis. Med Care, 47, 7 Suppl 1: S28-32.

Nganda, B., Wang'ombe, J., Floyd, K., & Kangangi, J. (2003). Cost and cost-effectiveness of increased community and primary care facility involvement in tuberculosis care in Machakos District, Kenya. Int J Tuberc Lung Dis, 7, 9 Suppl 1: S14-20.

Nguyen, D. T., Nguyen, H. Q., Beasley, R. P., Ford, C. E., Hwang, L. Y., & Graviss, E. A. (2012). Performance of Clinical Algorithms for Smear-Negative Tuberculosis in HIV-Infected Persons in Ho Chi Minh City, Vietnam. Tuberc Res Treat, 2012: 360852. doi: 10.1155/2012/360852

Nguyen, V. A., Choisy, M., Nguyen, D. H., Tran, T. H., Pham, K. L., Thi Dinh, P. T., . . . Dang, D. A. (2012). High prevalence of Beijing and EAI4-VNM genotypes among M. tuberculosis isolates in northern Vietnam: sampling effect, rural and urban disparities. PLoS One, 7, 9: e45553. doi: 10.1371/journal.pone.0045553

Nieto, E., Lopez, L., Del Corral, H., Marin, D., Lopera, L. D., Benjumea, D., . . . Arbelaez, M. P. (2012). [Cost-effectiveness of an alternative tuberculosis treatment: home-based guardian monitoring of patients]. Rev Panam Salud Publica, 32, 3: 178-184.

NTP. (2007). Guidelines for Public-Private-Mixed implementation in National Tuberculosis Program (ed.). Ho Chi Minh City, Vietnam: National Tuberculosis Program in Vietnam.

NTP. (2009). Guidelines for TB management (ed.). Ha Noi, Vietnam: Ministry of Health in Vietnam.

NTP. (2011). Annual report of national tuberculosis program. Ho Chi Minh City: Pham Ngoc Thach Tuberculosis and Lung Diseases Hospital, Ho Chi Minh City, Vietnam.

Pantoja, A., Lonnroth, K., Lal, S. S., Chauhan, L. S., Uplekar, M., Padma, M. R., . . . Floyd, K. (2009). Economic evaluation of public-private mix for tuberculosis care and control, India. Part II. Cost and cost-effectiveness. Int J Tuberc Lung Dis, 13, 6: 705-712.

Peabody, J. W., Shimkhada, R., Tan, C., Jr., & Luck, J. (2005). The burden of disease, economic costs and clinical consequences of tuberculosis in the Philippines. Health policy and planning, 20, 6: 347-353. doi: 10.1093/heapol/czi041

Petitti, D. B. (2000). Meta-analysis, decision analysis, and cost-effectiveness analysis: methods for quantitative synthesis in medicine (J. L. Kelsey, G. M. Marmot, D. P. Stolley & P. M. Vessey Eds. Vol. 312 ed.). New York, 10016: Oxford University Press, Inc.

Phillips, M., Mills, A., & Dye, C. (1993). Guidelines for cost-effectiveness analysis of vector control (ed.). Geneva: World Health Organization.

Prado, T. N., Wada, N., Guidoni, L. M., Golub, J. E., Dietze, R., & Maciel, E. L. (2011). Cost-effectiveness of community health worker versus home-based guardians for directly observed treatment of tuberculosis in Vitoria, Espirito Santo State, Brazil. Cad Saude Publica, 27, 5: 944-952.

Ray, T. K., Sharma, N., Singh, M. M., & Ingle, G. K. (2005). Economic burden of tuberculosis in patients attending DOT centres in Delhi. The Journal of communicable diseases, 37, 2: 93-98.

Resch, S. C., Salomon, J. A., Murray, M., & Weinstein, M. C. (2006). Cost-effectiveness of treating multidrug-resistant tuberculosis. PLoS Med, 3, 7: e241. doi: 10.1371/journal.pmed.0030241

Russell, L. B., Gold, M. R., Siegel, J. E., Daniels, N., & Weinstein, M. C. (1996). The role of cost-effectiveness analysis in health and medicine. Panel on Cost-Effectiveness in Health and Medicine. JAMA, 276, 14: 1172-1177.

Siegel, J. E., Weinstein, M. C., Russell, L. B., & Gold, M. R. (1996). Recommendations for reporting cost-effectiveness analyses. Panel on Cost-Effectiveness in Health and Medicine. JAMA, 276, 16: 1339-1341.

Sinanovic, E., & Kumaranayake, L. (2006). Financing and cost-effectiveness analysis of public-private partnerships: provision of tuberculosis treatment in South Africa. Cost effectiveness and resource allocation : C/E, 4: 11. doi: 10.1186/1478-7547-4-11

Steffen, R., Menzies, D., Oxlade, O., Pinto, M., de Castro, A. Z., Monteiro, P., & Trajman, A. (2010). Patients' costs and cost-effectiveness of tuberculosis treatment in DOTS and non-DOTS facilities in Rio de Janeiro, Brazil. PLoS One, 5, 11: e14014. doi: 10.1371/journal.pone.0014014

Suarez, P. G., Floyd, K., Portocarrero, J., Alarcon, E., Rapiti, E., Ramos, G., . . . Espinal, M. A. (2002). Feasibility and cost-effectiveness of standardised second-line drug treatment for chronic tuberculosis patients: a national cohort study in Peru. Lancet, 359, 9322: 1980-1989. doi: 10.1016/S0140-6736(02)08830-X

The World Bank. (2013). World Development Indicators. http://data.worldbank.org/

Tram, N. V., Bach, N. H., Anh, N. T., Duong, H. H., Thanh le, N. X., An le, V., . . . Cappuccinelli, P. (2012). Preliminary remarks on assembly whole genome sequencing of MDR M. tuberculosis isolated in Vietnam. J Infect Dev Ctries, 6, 1: 95-96.

Tupasi, T. E., Gupta, R., Quelapio, M. I., Orillaza, R. B., Mira, N. R., Mangubat, N. V., . . . Floyd, K. (2006). Feasibility and cost-effectiveness of treating multidrug-resistant tuberculosis: a cohort study in the Philippines. PLoS Med, 3, 9: e352. doi: 10.1371/journal.pmed.0030352

UN. (2012). The Millennium Development Goals Report 2012 (T. M. D. Goals, Trans.).

Vassall, A., Bagdadi, S., Bashour, H., Zaher, H., & Maaren, P. V. (2002). Cost-effectiveness of different treatment strategies for tuberculosis in Egypt and Syria. Int J Tuberc Lung Dis, 6, 12: 1083-1090.

Walker, D. (2001). Cost and cost-effectiveness guidelines: which ones to use? Health Policy Plan, 16, 1: 113-121.

Wandwalo, E., Robberstad, B., & Morkve, O. (2005). Cost and cost-effectiveness of community based and health facility based directly observed treatment of tuberculosis in Dar es Salaam, Tanzania. Cost Eff Resour Alloc, 3: 6. doi: 10.1186/1478-7547-3-6

Weinstein, M. C., Siegel, J. E., Gold, M. R., Kamlet, M. S., & Russell, L. B. (1996). Recommendations of the Panel on Cost-effectiveness in Health and Medicine. JAMA, 276, 15: 1253-1258.

WHO. (2003). Making choices in health: WHO guide to cost-effectiveness analysis (ed.). Geneva: World Health Organization.

WHO. (2008). Global tuberculosis control : surveillance, planning, financing.

WHO. (2010). Treatment of tuberculosis guidelines (4 ed.). Geneva: World Health Organization.

WHO. (2011). Early detection of Tuberculosis: an overview of approaches, guidelines and tools (ed.). Geneva: World Health Organization.

WHO. (2012a). Global tuberculosis report 2012 (W. H. Organization Ed. ed.). Geneva: World Health Organization.

WHO. (2012b). Tuberculosis Profile of Vietnam *Countries tuberculosis profiles*.

Wonderling, D., Sawyer, L., Fenu, E., Lovibond, K., & Laramee, P. (2011). National Clinical Guideline Centre cost-effectiveness assessment for the National Institute for Health and Clinical Excellence. Ann Intern Med, 154, 11: 758-765. doi: 10.1059/0003-4819-154-11-201106070-00008

Xu, Q., Jin, S. G., & Zhang, L. X. (2000). Cost effectiveness of DOTS and non-DOTS strategies for smear-positive pulmonary tuberculosis in Beijing. Biomed Environ Sci, 13, 4: 307-313.

Xu, Q., Wu, Z. L., Jin, S. G., & Zhang, L. X. (2002). Tuberculosis control priorities defined by using cost-effectiveness and burden of disease. Biomed Environ Sci, 15, 2: 172-176.

BIOGRAPHY

Name : Mr. Tran Nhat Quang

Date of birth : 01/01/1988

Place of birth : Ho Chi Minh City, Vietnam

Nationality : Vietnamese

Education : Bachelor of Public Health, graduated in 2010
Faculty of Public Health,
Ho Chi Minh City University of Medicine and Pharmacy,
Ho Chi Minh City, Vietnam

Academic publication:

Tran Nhat Quang, Truong Trong Hoang**. The current status and affecting factors of masturbation behavior of high school male students in district 5 in Ho Chi Minh City in 2010**. Bachelor. Public Health Faculty, University of Medicine and Pharmacy in Ho Chi Minh City, Vietnam. 2011.

Tran Dinh Thong, Tran Nhat Quang, Huynh Ho Ngoc Quynh. Perceptions and consciousness on the usages of homosexual intercourse protection means and the approaches to Voluntary Counseling and Testing services among MSM groups in Ho Chi Minh City in 2011. **Ho Chi Minh City Medical journal**. 2012:

Tran Ba Di, Tran Nhat Quang, Tran Thien Thuan. The prevalence of underweight, overweight, obese and its relative factors in pupil aged from 10 to 11 years old at Gia Rai B primary school, Gia Rai commune, Gia Rai district, Bac Lieu province, in 2011. **Ho Chi Minh City Medical journal**. 2012:

Le Duc Hanh, Tran Nhat Quang, Huynh Ho Ngoc Quynh. Knowledge, Attitude, Practice about STIs and contraceptives of Nguyen Hien high-school students in District 11, Ho Chi Minh city, in 2011. **Ho Chi Minh City Medical journal**. 2012:

Tran Thi Dieu, Truong Phi Hung, Tran Nhat Quang. Viewpoint on sex before marriage of female students, Nong Son high school, Nong Son District, Quang Nam Province in 2011.**Ho Chi Minh City Medical journal**. 2013:

Le Minh Nhat, Pham Phuong Thao, Tran Nhat Quang. Psychological consultant needs of student in Phu Nhuan high school, Ho Chi Minh City, in 2011. **Ho Chi Minh City Medical journal**. 2013:

Work : Lecturer,
Faculty of Public Health,
Ho Chi Minh City University of Medicine and Pharmacy,
Ho Chi Minh City, Vietnam