SOCIAL IMPACT ASSESSMENT OF CENTRAL HEALTHCARE WASTE INCINERATOR PROJECT IN YALA PROVINCE

PATTHANASAK KHAMMANEECHAN

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………..……………………………
Mr.Patthanasak Khammaneechan
Candidate

………………………………………..
Assoc. Prof. Kamolnetr Okanuruk,
Ph.D.
Major-Advisor

……………………………………
Prof. Pornchai Sithisarankul,
M.D., M.P.H., Dr.P.H.
Co-Advisor

……………………………………
Assist. Prof. Kraichat Tantrakarnapa,
Ph.D.
Co-Advisor

……………………………………..
Prof. Banchong Mahaisarariya,
M.D.
Dean
Faculty of Graduate Studies,
Mahidol University

………………………………………..
Assoc. Prof. Songsak Petmitr,
Ph.D.
Program Director
Doctor of Philosophy Program in
Tropical Medicine,
Mahidol University

Thesis
Entitled

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The degree of Doctor of Philosophy (Tropical Medicine)
on
December 9, 2009

…………………………………..
Mr.Patthanasak Khammaneechan
Candidate

…………………………………..
Miss Poonsup Norramit,
Ph.D.
Chair

……………………………………
Assoc.Prof.Kamolnetr Okanuruk,
Ph.D.
Member

……………………………………
Prof. Pornchai Sithisarankul,
M.D., M.P.H., Dr.P.H
Member

……………………………………
Assis. Prof.Kraichat Tantrakarnapa,
Ph.D
Member

.

…………………………………..
Prof. Banchong Mahaisarariya,
M.D.
Dean
Faculty of Graduate Studies,
Mahidol University

…………………………………..
Assoc. Prof. Pratap Singhasivanon,
M.B.B.S, M.P.H, Dr.P.H.
Dean
Faculty of Tropical Medicine,
Mahidol University

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Patthanasak Khammaneechan

SOCIAL IMPACT ASSESSMENT OF CENTRAL HEALTHCARE WASTE INCINERATOR PROJECT IN YALA PROVINCE

PATTHANASAK KHAMMANEECHAN 4738671 TMTM/D

Ph.D. (TROPICAL MEDICINE)

THESIS ADVISORY COMMITTEE: KAMOLNETR OKANURUK, Ph.D., PORNCHAI SITHISARANKUL, M.D., Dr.P.H., KRAICHAT TANTRAKARNAPA, Ph.D.

ABSTRACT

The aim of this evaluation research is to assess the social impact of the healthcare waste (HCW) incinerator project in Yala Province. Primary and secondary information were gathered. A combination of quantitative and qualitative methods were used to collect data from 300 villagers living near the project and 127 concerned healthcare workers based on their voluntary participation. Three rounds of data collection were done in the local community at baseline, construction and operational phases, and two rounds of data collection were performed in the healthcare service at the baseline and operational phases. Descriptive statistics were used to describe the characteristics of the study population and other variables. Chi-square test, Cochran's Q test, Wilcoxon sign rank test, and McNemar test were used to compare two or more data sets when appropriate. Content analysis was used for qualitative information.

The results showed that the project did not affect villagers' accessibility to healthcare service, education, and local water supply, but it significantly impacted villagers' health risk perception, road activities, and selection of drinking water. Some negative expectations such as bad smell, infectious organisms, and danger from car traffic increased significantly. However, some positive expectations such as job opportunities from the project, community development, and cleaner environment also resulted from the project. The community structure tended to change when a group of waste workers who were employed by the project became new leaders of the community. Improvement of HCW management in healthcare services was found. A cost benefit analysis showed that the project provided benefit to both healthcare services and the project vender.

In conclusion, the central HCW incinerator project induced both positive and negative social impacts to local villagers. Mitigation measures should be promoted to protect the health of local communities.

KEY WORDS : SOCIAL IMPACT ASSESSMENT/ HEALTHCARE WASTE/ INCINERATOR

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การประเมินผลกระทบทางสังคมจากโครงการสร้างเตาเผามูลฝอยติดเชื้อแบบศูนย์รวมที่จังหวัดยะลา
SOCIAL IMPACT ASSESSMENT OF CENTRAL HEALTHCARE WASTE INCINERATOR PROJECT IN YALA PROVINCE

พัฒนศักดิ์ คำมณีจันทร์ 4738671 TMTM/D

ปร.ด. (อายุรศาสตร์เขตร้อน)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์: กมลเนตร โอฆานุรักษ์, Ph.D., พรชัย สิทธิศรัณย์กุล, พ.บ., Dr.P.H., ไกรชาติ ตันตระกาลอาภา, Ph.D.

บทคัดย่อ

การศึกษาเพื่อประเมินผลกระทบทางสังคมจากโครงการเตาเผามูลฝอยติดเชื้อแบบศูนย์รวม การศึกษานี้ได้รวบรวมข้อมูลทั้งแบบปฐมภูมิและทุติยภูมิ ด้วยวิธีการทั้งเชิงคุณภาพและเชิงปริมาณจากตัวแทนครัวเรือนจำนวน 300 ครอบครัวที่อยู่ใกล้ที่ตั้งโครงการ และจากบุคลากรในสถานบริการสาธารณสุขจำนวน 127 แห่ง ที่สมัครใจให้ข้อมูล ข้อมูลจากครัวเรือนได้รวบรวม 3 ครั้งคือ ก่อนเริ่มโครงการ ขณะก่อสร้างโครงการ และหลังเปิดดำเนินการ ส่วนในสถานบริการสาธารณสุขเก็บรวบรวมข้อมูล 2 ครั้งคือ ก่อนเริ่มโครงการและหลังเปิดดำเนินการ ข้อมูลเชิงปริมาณวิเคราะห์ดดยใช้สถิติเชิงพรรณนาในการบรรยายลักษณะทางประชากรของกลุ่มตัวอย่างและตัวแปรอื่นๆที่ศึกษา ใช้สถิติ Chi-square test, Cochran’s Q test, Wilcoxon sign rank test และ McNemar test ในการวิเคราะห์เปรียบเทียบข้อมูลตั้งแต่ 2 ชุดขึ้นไปตามความเหมาะสม ส่วนข้อมูลเชิงคุณภาพวิเคราะห์โดยการวิเคราะห์เนื้อหา

ผลการศึกษาพบว่า โครงการไม่มีผลกระทบต่อการเข้าถึงบริการสุขภาพ การศึกษาและแหล่งน้ำใช้ของชุมชนท้องถิ่น แต่มีผลกระทบต่อการรับรู้ถึงความเสี่ยงต่อสุขภาพ การใช้ถนนและการแสวงหาน้ำดื่ม จำนวนผู้ที่คาดว่าจะเกิดปัญหาเรื่องกลิ่นเหม็น เชื้อโรคและอันตรายจากท้องถนนเพิ่มขึ้นอย่างมีนัยสำคัญ ส่วนผลดีที่คาดว่าจะเกิดเช่น โอกาสในการได้งานทำ การพัฒนาของชุมชนและการมีสิ่งแวดล้อมที่ดี นอกจากนั้นพบว่ามีแนวโน้มของการเปลี่ยนแปลงโครงสร้างในชุมชนท้องถิ่นเมื่อกลุ่มคนงานกำจัดขยะในโครงการกลายเป็นผู้นำใหม่ และพบว่าระบบการจัดการมูลฝอยติดเชื้อในพื้นที่ดีขึ้น ขณะที่ผลการวิเคราะห์ต้นทุนผลได้ก็พบผลดีต่อเจ้าของโครงการและประชาชนโดยรวมเช่นกัน

โครงการสร้างเตาเผามูลฝอยติดเชื้อแบบศูนย์รวมก่อผลกระทบทั้งเชิงบวกและเชิงลบแก่ชุมชนท้องถิ่น จึงควรส่งเสริมการใช้มาตรการในการป้องกันและแก้ไขผลกระทบเพื่อคุ้มครองชุมชนท้องถิ่นต่อไป

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LIST OF ABBREVIATIONS

ADB	The Asian Development Bank
CBA	Cost-benefit analysis
CEA	Cost-effectiveness analysis
EIA	Environmental impact assessment
EIEB	The Environmental Impact Evaluation Bureau
EIS	Environmental impact statement
EMS	Environmental management system
HCW	Healthcare waste
NEQA	National Environmental Quality Act
IA	Impact assessment
IEE	Initial environmental evaluation
IPD	In-patient Department
JBIC	The Japan Bank for International Cooperation
SIA	Social impact assessment
MNRE	The Minister of Natural Resources and Environment
MCA	Multi-criteria analysis
MSW	Municipal solid waste
NEB	The National Environment Board
ONEP	The Office of Natural Resources and Environmental Policy and Planning
OPD	Out-patient Department
UNEP	The United Nations Environment Programme
TOR	Term of reference

CHAPTER I
INTRODUCTION

1.1Rationales of the study

Environmental impact assessment (EIA) is a requirement before the development projects or activities approval. It is a process used to identify, predict, evaluate and manage the environmental impacts. EIA covers all biophysical, social, health and other relevant effects of the proposed project before approval decision made [1]. EIA aims at promoting sustainable development [1-3]. EIA process includes: screening, scoping, impact analysis, mitigation and impact management, reporting, approval process and follow up and evaluation [4-7]. EIA will provide information for decision-making, impact minimization and mitigation measures [1, 4]. Public involvement is recommended at least two times: at stage of scoping and review of EIA report [5]. In public involvement, the affected people should participate to identify important or interested environmental and social impact issues [8].

In Thailand, the first National Environmental Quality Act (NEQA), namely the Improvement and Conservation of National Environmental Quality Act was decreed in 1975. This decree required ten categories of development projects or activities to have EIA [9]. Then in 1992, NEQA decree required 22 categories of development projects or activities to conduct EIA before submitting for approval [9]. However, these 22 categories do not cover all categories of development projects [10].

There are two levels of impact assessment required in Thailand: initial environmental evaluation (IEE) and EIA. The projects that may not cause significant impact require IEE. If the project might cause significant impact, full scale EIA is needed [9]. EIA in Thailand covers four components, physical impact or abiotic resources, biological impact or biotic resources, human use values and quality of life values [11]. The first two components may be grouped as biophysical impact, while the last two components could be grouped as social impact. At present, EIA in Thailand covers both biophysical and social impacts. However, there are limitations of social impact data in the EIA report. Most social information in EIA report covered only socio-demographic data that may not be enough to identify or predict social impact [10]. Social information for social impact assessment (SIA) should cover information that might affect community activities, for example, people's perception and daily activities. [12].

The Thai SIA guideline was introduced in 1996 [13]. This guideline identifies a list of socio-demographic indicators to be selected. However, some approval projects could not be implemented because the local communities strongly opposed [14]. The Minister of Natural Resources and Environment (MNRE), then, appointed a committee to review the entire EIA process in 2003. One of the solutions proposed from the committee was that SIA must be part of EIA. In September 2006, the Office of Natural Resources and Environmental Policy and Planning (ONEP) introduced a new SIA guideline, without a standard procedure [15].

The goal of SIA is to provide various stakeholders with the fullest possible understanding of the social aspects [16]. SIA could provide information for conflict judgments [17] and promote equity for people [18]. SIA covers six categories of the human environment: biophysical and health, cultural, social, political, economic and psychological systems [19-26]. This study, therefore, conducted SIA of central healthcare waste (HCW) incinerator project in Yala province. It covered all social components as well as stages of development project. At present, there was no known SIA report in Thailand that covers all social issues; therefore, this study would help in developing SIA scoping and standard process in Thailand.

1.2 Objectives

1.2.1General objective

To study social impact assessment of central healthcare waste incinerator project in Yala province, Thailand.

1.2.2 Specific objectives

1) To study people's socio-demographic characteristics and perception toward healthcare waste and incinerator, and community infrastructure and service systems

2) To compare social information of baseline, construction and operation phases.

3) To study healthcare waste management of healthcare services in Yala province.

4) To compare healthcare waste management of healthcare services in Yala province before and after central healthcare waste incinerator project operation.

5) To study cost-benefit of healthcare waste management in Yala province.

1.3 Operational definitions

Social impact refers to the positive and negative changes of people's social components in both long-term and short-term.

Social cost benefit analysis refers to the study of proposal in term of its total economic costs and total economic benefits.

Healthcare waste (HCW) refers to materials discarded from healthcare activities including toxic substances and/or infectious agents.

Healthcare waste management refers to process used in healthcare waste segregation, collection, storage, transportation, and disposal.

1.4 Significance of the study

This study is the first full scale of social impact assessment in Thailand. It is a demonstration project for assessing social impact. It provides not only the appropriate indicators for SIA, but also the process of conducting SIA.

CHAPTER II
LITERATURE REVIEWS

This chapter separates into five parts: environmental impact assessment (EIA), social impact assessment (SIA), healthcare wastes (HCW), waste incinerators and introduction to Yala central HCW incinerator project.

2.1. Environmental Impact Assessment (EIA)

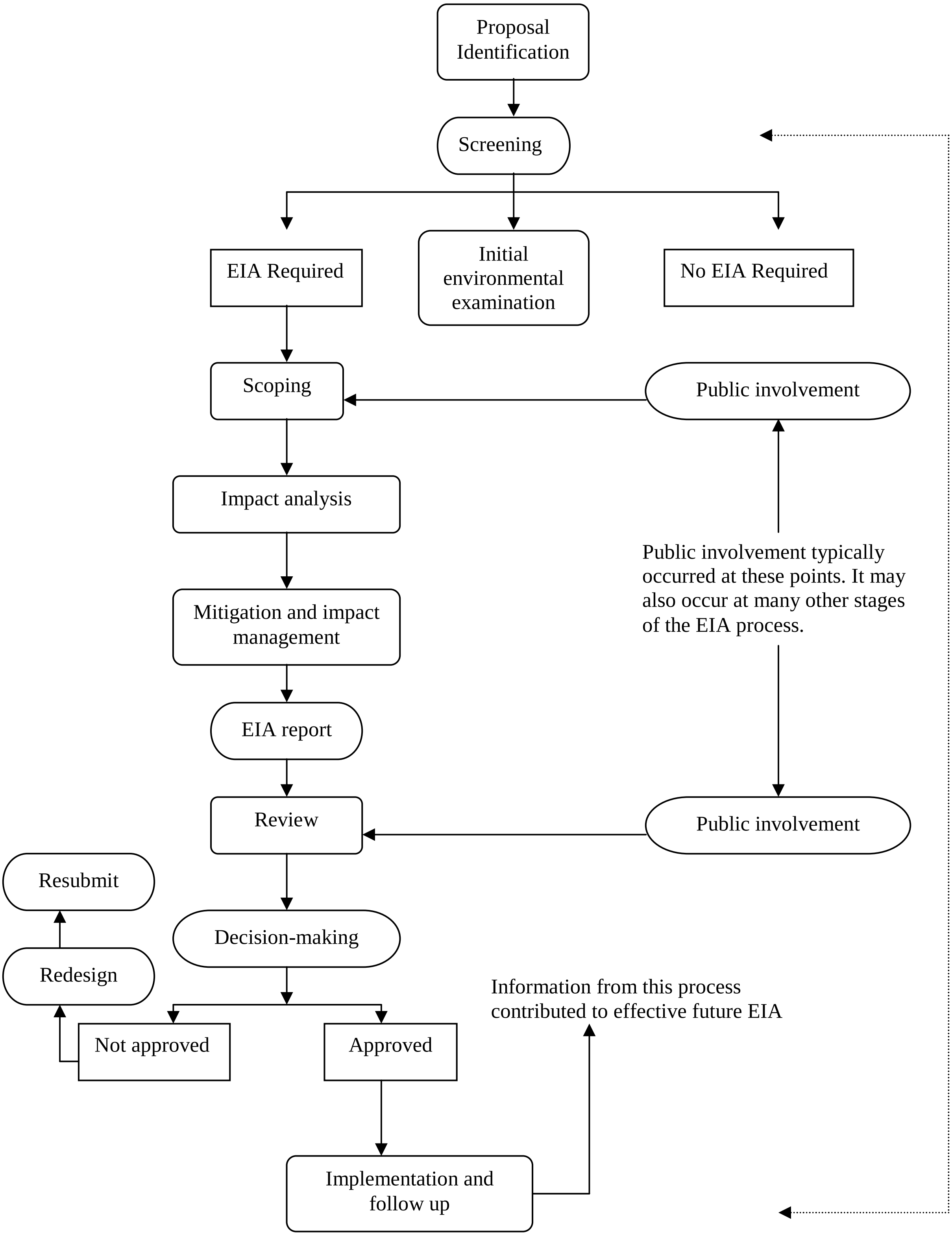
2.1.1 Definition of EIA

EIA is a process to identify, predict, evaluate and manage the biophysical, social, health and other relevant effects of development proposals before approval [1-3].

2.1.2 Elements of the EIA process

EIA is a requirement for development project that might affect the environment. EIA is a criterian used for international funding agencies in considering to support particular development project. Different agencies may have different EIA guidelines. The national EIA authority has also laid a national EIA guideline. A project funded by an international agency has to follow guideline of that agency. Others have to follow the national guideline. The United Nations Environment Programme (UNEP) recommends an EIA process flowchart as in figure 2.1 [5].

Figure 2.1 Generalized EIA process flowchart of UNEP



EIA process includes: screening, scoping, impact analysis, mitigation and impact management, EIA report and review, approval process, follow up and evaluation and public participation [4 -7].

2.1.2.1 Screening

Screening is a process to decide requirement level of environmental review. Some countries use prescribed lists or criteria for project screening [5]. The screening criteria vary from country to country or from agency to agency [2, 4, 5]. The World Bank has three categories for project screening [3, 27]. Category A, requires EIA, is for projects that potentially cause significant adverse environmental impact. Category B is for projects that may cause some adverse environmental impact in lesser degree than category A. This category requires an environmental review or initial environmental evaluation (IEE). Category C covers projects that unlikely to have adverse environmental impacts, so they do require neither EIA nor IEE. The Asian Development Bank (ADB) and the Japan Bank for International Cooperation (JBIC) have four categories for screening [2, 4]. The first three categories are similar to those of the World Bank [2, 4, 5]. The fourth category, financial intermediately (FI), is for projects that involve a credit line through a financial intermediately or an equity investment in a financial intermediately. The financial intermediately must report the environmental management system (EMS), unless all subprojects show insignificant environmental impact [2, 4].

2.1.2.2 Scoping

Scoping is the determination process for issues to be addressed, the information to be collected, and the analysis required to assess the environmental impacts of a project. The primary output of scoping is the term of reference (TOR) to conduct an EIA and to prepare an EIA report or environmental impact statement (EIS) [4]. Most of EIA authorities in Asia approve TOR for the EIA, but few funding agencies prepare their own [4]. TOR preparation is left to the proponent who normally contracts a team of EIA practitioners (EIA Team). Most TORs are prepared based on professional judgments [28], and then, submitted to the authorities or funding agencies [4, 28].

2.1.2.3 Impact analysis

A full-scale EIA involves collection of new information of environment and an in-depth analysis of the impacts. In this stage, experts in related fields are required. The full-scale EIA may involve detailed review procedures and requirements for public consultation. In most cases, consultants follow the guidelines developed by the authorities or the international assistance agency [2, 4-5]. These guidelines specify what should be included. However, the scope of the TOR is often too broad for the time and money available, and EIA reports do not always provide an in-depth analysis of the critical issues [28].

2.1.2.4 Mitigation and Impact Management

The environmental monitoring plan outlines the objectives of the monitoring; the specific information to be collected; the data collection process, including sampling design; and monitoring program. Environmental management is a part of project management responsible for implementation of mitigation measures and environmental monitoring. The environmental management plan outlines mitigation and other measures undertaken to ensure compliance with environmental laws and regulations. Mitigation and environmental impact management propose to reduce or eliminate adverse impacts, and to promote feasible environmental enhancement measures. Compensation and alternative techniques are recommended. Local or public opinions are also considered. Some funding agencies specify process of environmental managements. For example, JBIC (2002) [4] guides that environmental management should cover assigning institutional responsibility, reporting requirement, enforcement capability, and ensuring that adequate resources are provided in terms of fund, skilled staff, equipment, and supplementary training.

2.1.2.5 EIA report and review process

EIA reports are generally prepared by EIA practitioners. The quality of EIA reports depend on the practitioners’ capability, the budget availability, and the time frame. EIA reports are reviewed by a review agency or a special committee established to review projects in a given sector. In most cases, a technical evaluation of the EIA report is made by specialists [4]. The output of the review is either a rejection of the project, or an approval report outlining terms and conditions under which the project may proceed. These terms and conditions are attached to any license, permission, or certificate issued by the approval authority. Some funding agencies, for example, ADB and World Bank use experts for reviewing and evaluating of EIA reports submitted to them as part of their environmental assessment requirements [2, 3].

2.1.2.6. Approval process or decision-making

The results of an EIA review will be submitted to the agency responsible for approving the proposed project. For an approved project, some terms and conditions may be attached. These terms and conditions define the environmental protection measures that must be integrated into a project. The terms and conditions may also specify environmental monitoring undertaken in conjunction with the project. Disapproval will be returned to the proponent with some recommendations for improvement. Then, EIA process has to be conducted again followed the recommendations of the EIA agency [2-3].

2.1.2.7 Follow-up and evaluation

EIA follow-up is required to determine whether the environmental protection measures and monitoring program. Further follow-up may require to assess if the environmental protection measures are successful and the monitoring data have been analyzed and referred to. Follow-up is an important stage, however, many projects do not carry out [29-30].

2.1.2.8 Public participation

Public participation is required to allow affected people to identify significant environmental and social issues [31]. The UNEP recommended that public participation needs to be carried out at least two times, in scoping and review stages [5]. An effective EIA process takes issues raised by the public into account in the scoping stage. The public participation in review stage will help in addressing issues through appropriate environmental protection measures [1]. Although most developing countries have no formal requirements for public participation, the EIA team may consult community during the preparation of the EIA report [32]. Many development projects could not carry out because they do not address local needs or are not appropriate to local simulation [4].

2.1.3 Problems related to EIA

Quality of EIA performance depends on many factors, for example, time frame, money and quality or experience of EIA practitioners [4]. Over the past 25 years, the performance of EIA in developing countries, especially in Asia has been considered as unsatisfactory [33], although some reports included cost effective EIA methods and techniques [27, 34-37]. Some EIA performance created a negative image amongst those involved in promoting sustainable development [38], because the use of inappropriate tools and/or cover on limited components for sustaining development system. The weakness of EIA performance includes: narrow in scoping [6, 39, 41, 42], under standardizing review method [39, 40, 42, 43], lack of monitoring environmental management plan [6, 39] or fail to be demonstrative [42, 44], not involve the local community in all stages of the process [15, 39, 40, 42], and lack of information on cumulative impact [42, 45].

2.1.4 EIA in Thailand

The first National Environmental Quality Act (NEQA) known as the Improvement and Conservation of National Environmental Quality Act was decreed in 1975. As a result, the Office of National Environmental Board (ONEB) was established. The revised versions were decreed in 1978 and in 1981 [9, 11]. Since then, EIA has made some amendments of the act, and enactment of new acts. The amendments have addressed both the procedures and the institutional structure of EIA. At present, EIA has been under the Enhancement and Conservation of the National Environmental Quality Act version 1992 [9, 11].

Under the NEQA 1992, the Ministry of Natural Resource and Environment has to prepare and notify category and size of projects or activities for EIA reports. These notifications need from the National Environment Board (NEB). There are 22 types of projects or activities requiring EIA report.(Table 2.1) [11].

Table 2.1 Types and sizes of projects or activities required environmental impact assessment report in Thailand

Item	Types of Projects or Activities	Size
1	Dam or reservoir	With storage volume of 100 million cubic meter or more or storage surface area of 15 square kilometer or more
2	Irrigation	Irrigated area of 80,000 rai (12,800 hectare) or more
3	Highway or road as defined by Highway Act, passing through following areas: (1) Wildlife sanctuary and wildlife non-hunting area as defined by the Wildlife Conservation and Protection Act (2) National park as defined by the National Park Act (3) Watershed area classified as class 2 by the Cabinet Resolution (4) Mangrove forests designated as the National Forest Reserve (5) Coastal area within 50 meters of high tide level	All projects with equivalence to or above the minimum standard of rural highway, including road expansion on existing route
4	Commercial port	With capacity for vessel of 500 gross ton or more
5	Commercial airport	All sizes
6	Mass transit system under the Mass Transit System and Expressway Act or project as the same characteristic or mass transit which use rail	All sizes
7	Coastal land reclamation	All sizes
8	All type of projects located in the areas approved by the Cabinet as class 1B watershed area	All sizes

Table 2.1 Types and sizes of projects or activities required environmental impact assessment report for Thailand (cont.)

Item	Types of Projects or Activities	Size
9	Industries	
	(1) Petrochemical industry	Using raw materials which are produced from oil refining and/or natural gas separation, with production capacity of 100 ton/day or more
	(2) Oil refinery	All sizes
	(3) Natural gas separation or processing	All sizes
	(4) Chlor-alkaline industry requiring sodium chloride (NaCl) as raw material for production of sodium carbonate (Na_2CO_3), sodium hydroxide (NaOH), hydrochloric acid, chlorine (Cl_2), sodium hydro-chloride (NaOCl) and bleaching powder	Production capacity of each or combined products of 100 ton/day or more
	(5) Iron and /or steel industry	Product capacity of 100 ton/day or more
	(6) Cement industry	All sizes
	(7) Smelting industry other than iron and steel	Production capacity of 50 ton/day or more
	(8) Pulp industry	Production capacity of 50 ton/day or more
10	Pesticide industry producing active ingredient by chemical process	All sizes
11	Chemical fertilizer industry using chemical process	All sizes
12	Central waste treatment plant as defined by the Factory Act	All sizes

Table 2.1 Types and sizes of projects or activities required environmental impact assessment report for Thailand (cont.)

Item	Types of Projects or Activities	Size
13	Sugar industry (1) Production of raw sugar, white sugar, refined sugar (2) Producing glucose, dextrose, fructose or the like	 All sizes Production capacity of 20 ton/day or more
14	Industrial estate as defined by the Industrial Estate Authority of Thailand Act or projects with similar features	All sizes
15	Thermal power plant	Capacity of 10 MW or more
16	Petroleum development 1. Geophysical drilling, exploration and/or production 2. Oil and gas pipeline system	 All sizes All sizes
17	Mining as defined by the Mineral Act	All sizes
18	Hotel or resort facility	80 Rooms or more
19	Residential building as defined by the Building Control Act	80 Rooms or more
20	Building in area adjacent to river, coastal area, lake or beach or in the vicinity of the national park or historical park	With height of 23 meters or more, or total floor area or individual floor area in the building is 10,000 square meters or more
21	Land allocation of residential or commercial purpose	500 land pots or more or total developed area exceed 100 rai (16 hectare)

Table 2.1 Types and sizes of projects or activities required environmental impact assessment report for Thailand (cont.)

Item	Types of Projects or Activities	Size
22	Hospital which located 1. in area adjacent to river, coastal area, lake or beach 2. in area other than 1.	 1.With 30 beds or more 2.With 60 beds or more

In Thailand, there are two avenues for the EIA process. First, project or activity requires approval from the Cabinet, such as project or activity of a government agency or of state enterprises or those private enterprises to be jointly undertaken with the official rule and regulation. Second, project or activity that does not need Cabinet approval, for example, private sector project or activity [46].

The review process of EIA in Thailand will take about 75 days. The Environmental Impact Evaluation Bureau (EIEB) examines the EIA report submitted within 15 days. In this stage, the report will be examined whether it is duly made and completed or not. Then, the EIEB makes preliminary comment on EIA report within 15 days. After that the EIA report together with the preliminary comment will be reviewed and made decision by the Expert Review Committee within 45 days. This Committee consists of experts from various related disciplines and representatives from the authority legally competent to grant permission. If the report is approved, the permitting agency shall grant the permit for the project with condition of mitigation measure and monitoring program. If the report is not approved, the proponent has to revise the report and resubmit to the Committee. The Committee will review the revised report within 30 days after resubmission [11].

Many development projects in Thailand faced difficulty with social-environmental conflicts, for example, the projects of Pak Moon Dam, Hin Krud power plant, and Thailand-Malaysia pipeline [13]. Moreover, many EIA reports have been criticized on their quality. Problems of EIA in Thailand are similar to those in developing countries [4, 10], for instance having narrow scopes, especially the social and health factors, cumulative effects and indirect effects on systems and communities outside the project.

2.2. Social impact assessment (SIA)

2.2.1 Definitions of social impact and SIA

SIA is a process or tool to assess social impact [14, 47, 48]. Social impact is defined as all social and cultural consequences to people for example, people's demographic and socio-economic characteristics, norm, value, belief and perception [6, 20].

2.2.2 Theories related to SIA

SIA and impact assessment (IA) in general may be developed along with planning theory [49], especially the pragmatic planning theory and rational-comprehensive (R-C) [49-51].

2.2.2.1 Pragmatic planning theory

Lawrence (2000) [49] described that theory in SIA developed from experience of researchers who analyzed, defined the policy and observed it in practice. It has been developed as a tool to be used for the planning of projects, plans, programs and policies.

This theory accepts social values as an important part of decision making [50]. The theory implies that planning taken place within a short time frame with limitation of financial and human resources. Complex problems are brought down to a scale that can be solved. The problems in the process are solved by comparing past decision to the current situation or using experience as a measure of a plan's potential to solve a new problem. Lawrence (2000) [49] noted that impact assessment close to pragmatic planning theory through the introduction of streamlining, harmonization, procedural integration, and scoping. However, based on this theory, skilled practice and experiences of planner are needed to negotiate and adopt social values. Skills in qualitative analysis and participatory approach are also needed.

2.2.2.2 Rational – Comprehensive Planning Theory

Rational – comprehensive (R – C) planning aims to use all the information available or necessary in order to develop one plan that can be used in a long term. The monitoring step is necessary to ensure that the plan is working, but logically (and ideally), a planner working with this approach will assume that major changes will not have to be made to the plan through its completion. R – C planning begin with taking all the parts of a particular situation, then formulating a plan that could address all of those parts in an expected way, would generate ideal plans for that situation [51]. Therefore, planning requires a high level of knowledge about each topic, and the technological ability to use it [52]. As a result, quantitative analysis is often a central element of analysis [53].

R – C planning should be accomplished by well-established steps [51, 54]. These steps are used in various impact assessments.

1. Identify or define the problem;

2. Establish goal and objective;

3. Collect background data;

4. Identify alternative means to achieve the goal and objective, and means to assess each alternative;

5. Assess each alternative;

6. Select the preferred alternative;

7. Implement the plan; and

8. Monitor, evaluate and revise the plan.

R-C planning is based on following assumptions [51, 54]:

1. People behave rationally: they can identify and rank goal, value, and objective and can make consistent decision based on systematic collection and analysis necessary data;

2. Assumes perfect information: the information is affordable and available;

3. All information exist as unbiased and valueless;

4. Events will occur in a rational-deductive sequence: no need for political strategy, and unforeseen events because all events have been accounted for.

2.2.3 SIA methods

Methods used to collect data for SIA are not different from other social science study. SIA investigators may use the following data collection methods and combine some of them as appropriate [55-56]; analyze stakeholder, develop community or social profiles, set up community consultations and community participation process, conduct focus group discussion, interview informally or in-depthed, analyze secondary data, conduct social survey, and visit site and observe activities and environment related to the project.

2.2.4 SIA techniques

Techniques used in the study of SIA are not different from other social studies but SIA will focus on social impacts of the development intervention. There are some techniques often used in SIA study [55-57].

2.2.4.1 Descriptive matrices

Descriptive matrices refer to tables or charts that summarizes the costs and/or benefits, usually, qualitative terms [58]. This approach is simple and easily understood, it requires basis for category of positive and negative aspects of the proposal.

2.2.4.2 Cost-benefit analysis (CBA)

This is a well known and used economic technique designed to allow the expected costs and benefits to be weighed up in monetary terms. This analysis also can compare the net costs or benefits of different projects or scenarios. For any particular proposal, benefit should exceed cost to be justified. It’s alternative proposals are compared, the one with highest net benefit should be favored. CBA is a straightforward technique, but it requires many assumptions to allow monetary values to be assigned. Some of these assumptions may be controversial. Time frames used to assess costs and benefits may be short, and monetary values assigned may not adequately reflect values held by people in different community sectors. Estimating cost or benefits of non-market goods or services may require specialized economic valuation techniques [55, 59].

2.2.4.3 Cost-effectiveness analysis (CEA)

This technique is closely related to cost-benefit analysis. It focuses on identifying the most cost-effective proposal for achieving a pre-designed outcome. It should be applied for project design since it focuses on design. It requires a carefully specified outcome or objective. For deciding on its outcome, agreement from stakeholders is needed and consultation may be required. This technique design may become a complex if the programs have more than one objective [55].

2.2.4.4 Multi-criteria analyses (MCA)

SIA often requires a set of alternative proposals or identified aspects of proposals. This analysis can produce score for each criterion and an overall ranking of proposals, but does not attempt to put monetary value on the cost or benefit. MCA can identify how stakeholders view the alternatives and which aspects of alternatives they agree [55]. Therefore, this analysis is a good stakeholder involvement tool. By involving stakeholders and clarifying judgment criteria, it can make decision more transparent. The results of the analysis can be presented in impact or effect summary table. Coakes (1997) [56] provides a multi-criteria analysis table showing a set of characteristics of town dependent on native forest logging that could be used to evaluate the social impacts for restriction area.

2.2.4.5 Social indicators

Indicators may rely on primary or secondary data. Sets of indicators or indicator frameworks are used for MCA. In designing indicators for measuring the effectiveness of the implementation of development proposals, both qualitative and quantitative information should be taken [60-61]. However, certain topics, particularly in the field of social performance measurement, quantitative data may be difficult to get [62]. Therefore, qualitative measurement has to be relied on [60].

Social indicators have both strength and weakness [62-63]. Social indicators allow for systematic comparison across spatial units and over time. They can provide a concise description of socioeconomic conditions, such as the proportion of people below the poverty line [62]. They are easily accessible, and can be interpreted by non-experts. Social indicators are useful in policy analysis, decision-making and program evaluation. Some weaknesses of social indicators include: they depend on secondary information, they are often not available at levels or periods useful to decision-makers [63].

The key characteristics and variables that are often correlated with adverse social impact of development proposal include [64]:

1. lifestyle impact – on the way people behave and relate to family and friend on a day-to-day basis;
2. cultural impact – on shared custom, obligation, value, language, religious belief and other elements which make a social or ethnic group distinct;
3. community impact – on infrastructure, service, voluntary organization, activity network and cohesion;
4. quality of life impact – on sense of place, aesthetic and heritage, perception of belonging, security and livability, and aspiration for the future; and
5. health impact – on mental, physical and social well-being

2.2.4.6 Scenario planning

This technique provides information in different situations of the project. The scenario should be presented to stakeholders to evaluate the reaction [65]. Scenario planning can engage the interest of stakeholder and broaden the range of stakeholders represented in community consultation or participation process. Some advantages are that it explores uncertainty surrounding the project, engages stakeholders in the planning and monitoring process. However, the providing information by this technique is suitable for update implementation project.

2.2.4.7 Social judgment

Social judgment technique allows respondents to nominate their important dimension or attribute of a proposal, rate the proposal as positive or negative on the dimension, and rate the importance of each dimension in relation to others [66]. From this rating, scores can be developed for each dimension, normalized, and combined to produce an overall value for both cost and benefit of the proposal. Cost can be subtracted from benefit to produce a utility score for each respondent. These scores can then be aggregated and compared across respondents. This technique has some advantages that it involves stakeholders to examine relevant issues, enhances local learning and management skills and provides reliable information for decision-making. However, they are time consuming and tend to be dominated and misused by stakeholders.

2.2.4.8 Geographical and spatial techniques

These techniques depend on access to secondary data aggregated in ways appropriate to assessing impacts of particular proposals. Spatial of distribution of social impact may be a key decision for politician or decision maker [67, 68]. In these techniques, direct towards identifying socially meaningful geographical boundaries rather than accepting pre-existing administrative boundaries developed for other purposes. These pre-existing boundaries may not match with community place attachments or everyday behavior patterns. After socially meaningful boundaries are developed, they can serve as the basis for further spatial analysis of socio-economic data relevant to the proposal.

2.2.4.9 Applied models for SIA

Some social sciences models have been applied for SIA [69], for example, community response model, social organization model and community organization model. These models may be used as tools for social impact description and social change process. Some advantages are that these provide basis to assess impact of project, help in prioritizing which issues to be investigated in more detail. Some disadvantages are that stakeholders might disagree with determining factors and the SIA can easily become over complex if scale of activities is large.

This study will use a combination of social indicators, cost-benefit analysis, geographical and spatial, and social judgment techniques. The social indicator is suitable for comparing information in different time. The cost-benefit analysis is applicable in identifying cost and benefit of the project in monetary term. For social judgment technique, it will help in promoting stakeholders to examine relevant issues, enhancing local learning and management skills. Areas might be impacted will be scoped by geographical and spatial technique.

2.2.5 SIA process

There are many different descriptions of the SIA process [15, 70-73] but have the same elements. Typically, SIA process is the 10 steps produced by the Interorganizational Committee on Guidelines and Principles for Social Impact Assessment (ICGPSIA), [20].

1. Public involvement: identify and involve all potentially affected people.
2. Identification of alternatives: describe the proposed action and reasonable alternatives.
3. Profile baseline conditions: equal to EIA baseline study.
4. Scoping: identify the type of expected social impacts.
5. Projection of estimated effects: determine probable impacts, including direct, indirect, and cumulative impacts
6. Prediction of responses to impacts: determine the importance of the identified impacts
7. Changes in alternatives
8. Mitigation: through avoidance, minimization or compensation measures.
9. Monitoring: identify deviations and any important unanticipated impacts.
10. Audit: not just predictions review, but also review of the whole procedure of SIA.

2.2.6 Applications of SIA

SIA could promote more democratic process by ensuring equity and transparency in decision-making, if incorporated local knowledge. It could be used as a tool to identify social environmental impacts and define impact prevention, mitigation measures and monitoring. SIA process could be applied to a wide range of interventions. It was implicit that social and biophysical impacts were interconnected.

SIA could support social sustainability and finally supported more sustainable world [13, 74].

SIA could help project planners to evaluate society's ability and willingness to adjust to project as well as to identify beforehand different problems and interests [75]. The use of SIA in advance brings out the significance of the project as well as identifies the possibilities to mitigate the possible future disadvantages [76-78]. With SIA, planners were able to foresee and clear out the effects that would affect the developing areas and inhabitants' way of life [79]. Additionally, it could give ways to take into account and arbitrate possible future conflicts [16]. SIA brought as well the aspects of equity to the project evaluation.

2.2.7 SIA limitations

SIA are not widely applied when compared to EIA [73]. Business professional and decision maker did not consider SIA reports because the reports were difficult to understand by non-social scientists [73]. Even though SIA is a particular advantageous tool to identify social environment impact of the proposed projects, it still needs more studies or developments for the most advantage of human populations [69].

2.2.8 Research related to SIA

There are small amount of SIA published articles when compare to those of EIA. Other practitioners inferred SIA in term of socio-economic impact assessment [80-81]. Some publications related to SIA are as follows:

Scott [76] applied a participatory method to assess social impact of marine waste disposal project in Southern Kwazulu-Natal by putting the community structure, nature of conflict and a set of parameters to ensure equal opportunity in the process. He found that more participants accepted local knowledge and qualitative information. However, it was found that this participatory method was quite long and expensive process, and difficult to control all representative from various groups of stakeholders.

Davies et. al.[82] used a questionnaire to study attitude and action toward waste management in Ireland. The study covered 1500 households, it was found that 86% of respondents concerned about environmental condition. It was found that factors affected waste management behaviors of householders were multiple and intertwined, and to change people's behavior was not an easy task.

Lima and Marques [77] assessed psychological impacts of the solid waste incinerator in the North of Portugal. A longitudinal study had been conducted during 1977-2004. Two groups of respondents were divided based on the distance from the incinerator. The study group was respondents resided far from the incinerator not more than two kilometers radius, and the control group was those who lived farther than two kilometers. They found that distance from incinerator and risk perception were good predictors for psychological impact.

Glasson [83] reviewed a longitudinal research for monitoring of the Sizewell B nuclear power station in the UK. The results showed that economic impacts which firstly being considered as beneficial impacts was turned to the opposite way because the developers brought their own construction workforce. A major influx of immigrants to the area impacted local accommodation market and local service. Crime was also a predominant problem in the local community.

Lavallee and Andre [84] reviewed social impact follow-up from the past 25 years of EIA practice, they found that only 7 % of social impacts recommended in the EIA were implemented. They concluded that social impact follow-up was very limited because the public administration did not provide legal framework, supervise and encourage the implementation.

Petäjärvi [78] conducted a socioeconomic follow-up study in Finland on a project of road and bridge construction from the Paippaluoto Island to the mainland. The results showed that, during operation period, average daily road traffic was predominantly increased; rate of population growth had been more than double but the number of jobs was slightly decreased because one industrial enterprise closed down.

A practice of environmental and social impact assessment in Bangladesh was demonstrated by Momtaz [85], using a case of Khulna-Jessore drainage rehabilitation project. Varied methods were adopted to predict impacts: rapid rural appraisal, community participation and multi-criteria analysis technique. It was reported that SIA was possible to conduct as a part of EIA. Community opinions and values collected through SIA significantly influenced the outcome of the process.

Edelstein [86] demonstrated a psychosocial impact of proposed environmentally hazardous facilities. Multimethods were designed to collect data were six focus group discussions, 30 community residents interviews, and 10% random sample of community's residents surveys via phone. The results showed that 70% expected future harm from the waste facility, 73% indicated that the plant threat their well-being and 80% believed water was likely to be contaminated. However, psychosocial impact was inconclusive.

Taylor et al. [16] applied SIA for supporting decision on a proposal to build a large shopping centre on a Greenfield site at Upper Hutt, New Zealand. In that study, SIA scoping based on various sources of information: a site visit, key-informant interview and review of background document. Multiple methods for data collection were designed: telephone interview, in-depth interview, related secondary data collection. The study was well-defined impacts on the social and economic well-being of the community, whereas the project developer had not produced an adequate assessment. Conflicts occurred between developer and the opponents. Based on the SIA existing data, the court subsequently ruled out the proposed project.

Lane et al. [17] demonstrated the role of SIA in resolution of an environmental conflict due to a proposal to exploit mineral wealth in Australia. There were three methods used: a strategic perspective analysis (SPA) for qualitative data exploration, a standard SIA technique for quantitative data prediction, and a community response model for understanding of community structure and process. It was found that there were some impacts on culture, psychological, health and social of Aborigines and Jawoyn. Local economic development may be disappointed because the mine was unlikely to provide high level of employment or related development opportunity. Based on this SIA data, the proposed project was not approved. However, it was found that a combination of SIA methods was feasible and better in understanding complexity of the society.

2.3. Healthcare wastes (HCW)

2.3.1 Characteristics of HCW

HCW includes discarded materials from healthcare activities on human or animal [87]. It includes both biological and non-biological healthcare wastes. About 85% of these are non-hazardous wastes, 10% are infectious wastes, and 5% are non-infectious but hazardous wastes [88-89]. Infectious wastes are produced from diagnosis, monitoring and preventive, curative or palliative activities in the field of the veterinary and medicine. Infectious waste also included those of the biological production or testing. Some toxic substances, for example, discarded drugs, radioactive materials, antineoplastics etc., which may not be contaminated with blood and its derivatives, tissues, tissue fluids or excreta, or wastes from infection isolation wards are included in hazardous wastes.

2.3.2 Health hazards related to HCW

HCW represents only a small part of total wastes, but it is a focal point of public concern because of ethical question and infection risks [90]. It has been estimated that there were about 5.2 millions death of waste related diseases around the world [90]. WHO [87] summarized public health risk of healthcare wastes as:

1) It is possible to contaminate drinking water, especially when source of drinking water system comes from surface water.

2) Non-biodegradable antibiotics, antineoplastics and disinfectants disposed into the sewage system may kill bacteria necessary for the treatment of sewage. Furthermore, when these chemicals flushed into water resource, they may damage aquatic life or contaminate drinking water.

3) Burning of waste at low temperature or in open container distributes toxic pollutants (e.g. dioxin) into the air.

4) Carcinogenic waste such as heavy metals, chemical solvents and preservatives pose serious human health risks not only to workers but to the public as well.

2.3.3 HCW in Thailand

The Department of Pollution Control reported that infectious waste generated in Thailand in 2001 were about 15,300 tons and in 2002 were increased up to 16,000 tons. There are about 2400 clinics and more than 1,400 hospitals in 2002. Of these, only 17 percents dispose their infectious wastes by Local Administrative Organization (LAO) service. Most hospitals use on-site incinerators. In Thailand, there are 880 hospitals under the control of the Ministry of Public Health and most hospitals have their own incinerators. Unfortunately, only 22 incinerators (2.5%) operated with full function. Most hospital incinerators (89.0%) work but they are often broken, operated incorrectly, and/or lack pollution control equipment. Some hospital incinerators (7.5%) are closed because of non-function and receiving complaints from surrounding populations. Nowadays, hazardous waste is a priority of environmental health issue of Thailand [91].

2.4 Waste incinerators

Incinerator is a tool to transfer combustible solid wastes into energy, gases and ashes. Solid waste incineration has played an important role in solving the problem of scarcity of available land for municipal solid waste (MSW) landfills [92]. Incineration is considered as method of choice for most infectious wastes management [88]. The incineration is a high temperature dry oxidation process that reduces organics and combustible wastes to inorganic or incombustible matters. Solid waste incineration results in very significant reduction of waste volume and weight.

2.4.1 Incineration Advantages

Incineration is an efficient way to reduce waste volume and demand for landfill space. Incineration plants can be located close to the center of waste generation, thus reducing the cost of waste transportation. Using the ash from MSW incinerators with environmentally appropriate construction not only provides a low cost aggregate but also reduces the need for landfill capacity. Energy can be recovered for heat or power consumption. Incineration provides the best way to eliminate methane gas emissions from waste management processes. Furthermore, energy from waste projects provides a substitute for fossil fuel combustion. It can be used to reduce original volume of combustibles by 80 to 95 percents [92].

2.4.2 Incineration Disadvantages

An incineration plant involves heavy investments and high operating costs and requires both local and foreign currency throughout its operation [88]. Not all kinds of wastes are appropriate to be burned. The composition of waste in developing countries is often questionable in terms of its suitability for auto-combustion. The complexity of an incineration plant requires skilled staff. Pollutions may occur when incinerator is handled inappropriately [87].

2.4.3 Social concern about waste incinerator

Anti-incineration movements have been studied in a range of different locations with different perspectives [93]. The examples are anti-incineration networks and on the nature of campaigning discourses while the struggle over incineration are occurred [93-96].

2.5. Yala HCW incinerator project description

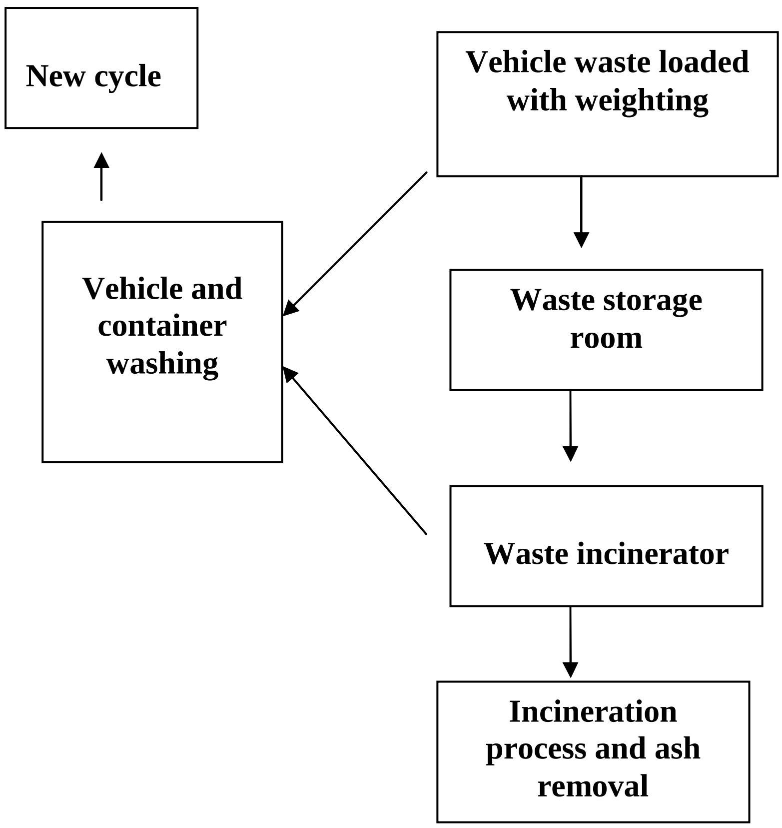
Inception of central HCW management in the three bordered provinces, Yala, Pattani and Narathiwat, occurred after five years operated of the Hat Yai central HCW incinerator. There were many HCW from various sources in the lower southern region going to Hat Yai central HCW incinerator. Five years after operation, capacity of the Hat Yai central HCW incinerator was not enough to support HCW management in the region. The other HCW incinerators have been considered for more appropriate share and distribution, and the three-bordered provinces have been prioritized. There were three choices for project site; 1) rehabilitation of unused hazardous waste incinerator at Pattani industrial area, 2) new plant designed at Ma Yoa district, Pattani and 3) new plant designed in Yala. The first two choices have been strongly opposed while the third choice is feasible because the plant will be on the land of Yala municipality and far from the community. Time frames of the project were as follows:

- Planning stage, in 2004, contact funding agencies. The EIA was then conducted and approved
- Approval stage, in 2005, the project was approved by financial agency in November 2005
- March 2006, a workshop was conducted for notifying stakeholders
- August 2006, selected project constructor
- August 2006-March 2007, land clearance for project construction
- March – July 2007, project construction
- July 2007, operational testing
- July 2007, started operation of the project

The Satang-Nok subdistrict, Mueng district was selected for project setting. It is about 10 kilometers from Mueng Yala municipality. This project planned to support the three southern bordered provinces (Yala, Pattani, and Narathiwat) in healthcare waste (HCW) disposal. A survey in 2005 found that average of HCW generated in these provinces was one ton/day. Within two kilometers from the site, there are two villages having 250 households, 2500 peoples. The two villages that closed to the project plant have been settled for more than 50 years. Most of the villagers are farmers for rubber plantation, fruit orchard and rice field.

In the waste management process of the plant, a waste vehicle will be weighted, and then all waste with its containers will be carried into the storage room with temperature below 10 degree Celsius. Workers will carry waste in the storage room to the incinerator. An automatic machine will be used for waste feeding into the first chamber. The waste container will be brought to the washed room by workers. All vehicles will also be washed in this area. (Figure 2.2).

Figure 2.2 Waste management process for Yala HCW incinerator plant



For incinerator specifications, a Swedish technology, rotary kiln has been used. Its capacity is 6 tons/day. There are two chambers for burning processes. A first chamber is automatically rotated during its working for more completion of burning. Temperatures in this process range from 850-1200 degree Celsius. The optimum operation is at 1100 degree Celsius. The secondary chamber will be operated at 1000 - 1200 degree Celsius, with 2 seconds of retention time. Heating and emission gases will be cooled down and treated with wet scrubbing system before releasing to the environment.

The EIA report was reviewed. Most data in the EIA report generated from secondary data. The report focused on advantages of Mueng Yala and improvement of HCW management system in the region. Data in part of Quality of life was reported in only districted and provincial levels. Sub-districted data was not available. Some potential adverse impacts showed in the report were impacts from wastewater to land and underground water, increase in average daily traffic, impacts from incinerator emission gases, heat and particulate matters and occupational health risk of waste workers and labors during construction.

For mitigation measure and management, a wastewater treatment plant (aeration ponds) was constructed, and periodically checked for quality of discharged water. Incinerator emissions would be annually checked for air quality, and emission control equipments would be annually checked. Waste workers, including vehicle drivers would be trained and provided suitable personal protective equipments. A concrete road to the plant was constructed. Consideration of health and living condition of workers during plant construction were also recommended. However, it could be concluded that the EIA report lacked of social impact data, for example, data of villages nearby the plant were not available. Off-site impacts were also not identified.

CHAPTER III
MATERIALS AND METHODS

3.1 Study design

This study is an evaluation research. Data for on-site impacts were collected three times: pre-construction or baseline, construction and operation phases. Data related to off-site impact were gathered two times: pre-construction and operation phases.

3.2 Study setting

The study covered all 372 households located within five kilometers radius of the Yala central HCW incinerator plant namely: Ban Prama and Ban Nibong-baru at Satang-Nork Subdistrict, Maueng District, Ban Bukaelango, Wangphya Sub-district, Raman District, Yala Province and Ban Tontamsao, Khaotom Subdistrict, Yarang District, Pattani Province. For off-site impact, all 142-healthcare services, such as hospital, health center, primary care unit, medical clinic, dental clinic, veterinarian clinic in Yala province were recruited.

3.3 Study population

The populations in this study were divided into two groups: on-site group and off-site group.

3.3.1 On-site group

Households in five kilometers radius of the HCW incinerator plant were asked to participate in the study. Inclusion criteria were: 1) living in Ban Prama or Ban Nibongbaru or Ban Bukaelango or Ban Tontamsao, 2) being head of family or representative who was 18 years old or above, stayed in the community at least six months, 3) willing to participate in the study. Exclusion criteria were: 1) not willing to participate, 2) unable to communicate with the interviewer.

3.3.2 Off-site group

Health officials and private clinical owners or representatives were invited to participate in the study. Inclusion criteria were: 1) working in healthcare services in target area, 2) Responsible for healthcare waste management, 3) willing to participate in the study. Exclusion criteria were: 1) not willing to participate, 2) unable to communicate with the interviewer.

3.4 Sample size determination

3.4.1 Sample size for studying on-site impacts

All households within five kilometers radius of the HCW incinerator plant were recruited.

3.4.1 Sample size for studying off-site impact

All healthcare providers whose work related to HCW management and private clinical owners or representatives were invited to enroll in the study.

3.5 Methods

The study gathered both primary and secondary data.

3.5.1 Primary data

This study employed a combination of structured interview, in-depth interview, observation and informal interview in gathering information.

3.5.1.1 On-site

3.5.1.1.1 Structured interview was used to collect data from the head of family or representative.

3.5.1.1.2 In-depth interview was employed to collect information from community leaders.

3.5.1.1.3 Observation and informal interview were used to gather information on business activities, land use pattern, traffic to the plant and surrounding areas, construction process and activities, operational process and activities.

3.5.1.2 Off-site

Primary data was collected from healthcare workers or private clinical owners or representatives. Data collected includes: methods and cost related to HCW storage, collection, transportation, disposal, and opinion toward HCW management.

3.5.1.3 Focus group discussion

The focus group discussion was conducted in November 2008 by using study results of local community part and related data as the framework for discussion. The stakeholders enrolled in the forum include: community leader, primary healthcare volunteers, affected people, local health official, local government staff, waste worker, teacher, religion leader and interested person. There were 12 stakeholders participated in the focus group discussion and 46 observers.

3.5.2 Secondary data

Secondary data were collected from various sources including:

1) Health center data bank: data collected were numbers and characteristics of population, sources of water supply, numbers of community leaders, for example.

2) Local government: data related to capacity and development of roads, power and water supply in the communities were gathered.

3) Community school: numbers and names of educational institutions, capacity and number of current students were collected.

4) Project proponent: data collected including employees' data both outside and inside the construction villages, rate of electricity consumption, fuel and

water used, investment of incinerator preparation and construction, cost of HCW collection, transportation, storage and incineration, for example.

5) Healthcare service: cost of HCW segregation, storage, collection, transportation and disposal, and opinion toward current HCW management were gathered.

3.6 Instrument

3.6.1 Questionnaire I was used for collecting data at family level (Appendix A). It was divided into five parts.

Part 1: included participants' socio-demographic characteristics, such as, age, sex, educational level and occupation.

Part 2: covered accessibility to community infrastructures and services, for example, healthcare services, transportation, school, drinking water and water supply etc.

Part 3: covered respondents' expectation from the HCW incinerator project, both positive and negative.

Part 4: included respondents' perception of health risk, for instance, perception toward risk of HCW, noise, unusual odor, air pollution, contaminated water, contaminated foods and traffic.

Part 5: covered other problems and recommendations related to the project.

3.6.2 Questionnaire II was used to collect data at healthcare services (Appendix B). The questionnaire covered socio-demographic characteristics of respondents, current method of HCW segregation, storage, collection and disposal, cost of HCW management, and opinion toward HCW management, for example.

3.6.3 In-depth interview guide was used to interview community leaders (Appendix C). Topics interviewed were opinion toward the incinerator project, villager migration pattern and cause, community organization, local tradition and practice, expected impact on land and housing.

3.6.4 Validity and reliability of instruments

Questionnaire I was pre-tested with 30 people living nearby Khok-Phoe Hospital waste incinerator, Pattani Province in March 2006. Then, the questionnaire was modified according to the result of the pre-test. The reliability of the questionnaire was computed using coefficients of Cronbach's alpha [97]. The alpha score was 0.7391.

Questionnaire II was pre-tested with 16 health officials in hospital and health centers in Khok-Phoe District, Pattani Province, and the modification was made.

3.7. Data analysis

3.7.1 Descriptive statistics

The descriptive statistics, for example, frequency, percentage, mean and standard deviation were used to describe respondents' characteristics, public services, road activities, religion activities, expectation toward the project, health risk perception toward the project, experience related to HCW incinerator project, HCW management and costs in healthcare services.

Scores of health risk perception were separated into 3 levels as follows:

Scores	Levels of perception
< 60.00%	Low
60.00 % to 79.99 %	Moderate
80.00% and above	High

3.7.2 Inferential statistics

3.7.2.1 Chi-square test was used to compare three groups of nominal scale variables that did not match or did not repeated measure, for example, accessibility to healthcare service, accessibility to water, road activities, religion activities, category of risk perceptions.

3.7.2.2 Chi-square test or Fisher's exact test were used to compare two groups of nominal scale variables that did not match or did not repeated measures, for example, characteristics of healthcare services' informer, HCW managements, Opinions toward HCW managements. In condition, Fisher's exact test was used instead of Chi-square test when at least 20% of expected values in chi-square table were less than five.

3.7.2.3 Cochran' Q test was used to compare three groups of nominal scale repeated measures variables, for example, expectation to the HCW incinerator project, opinions related to religion activities, road activities, Yala hospital, and Satang Nok health center.

3.7.2.4 McNemar test was used to compare two groups of nominal scale repeated measure variables, for example, expectation to the HCW incinerator project, opinions related to religion activities, road activities, Yala hospital, and Satang-Nork health center.

3.7.2.5 Wilcoxon signed rank test was used to compare two groups of interval scale repeated measure variables that presented no normal distribution, for example, costs of HCW management.

3.8. Traffic volume analysis

Traffic volume study followed the guideline of the Bureau of maintenance and traffic safety, Department of Rural Roads [98]. Ban Prama's main road was observed at the same period of community data collection. In each phase, traffic volume manual counts were performed on Sunday, Tuesday and Thursday for a week. Times of vehicle count in a day were between 8.00-9.00 a.m. and between 2.00-3.00 p.m. Data of vehicles gathered were used to estimate number of vehicles per day. Then, average daily traffic (ADT) was estimated. The ADT was presented as number of vehicle per day, and passenger car unit (PCU) per day. According to the Bureau of Maintenance and Traffic Safety [98], the vehicles were classified into four categories, bicycle, motorcycle, vehicle with four wheels, and vehicle with six wheels and above. For estimating PCU from the classified vehicles, guideline of the Bureau of Maintenance and Traffic Safety [98] was used as follows:

Types of vehicle	**PCU**
Bicycle	1/5
Motorcycle	1/3
Vehicle with four wheels	1
Vehicle with six wheels and above	2

3.9. Cost-benefit analysis

The cost benefit analysis **(**CBA) methods followed the European Commission guide to cost–benefit analysis of investment projects [99]. Cost and benefit presented on an annual basis. Two scenarios were used; baseline phase and operation phase. Costs and benefits of HCW management were analyzed separately for each group of healthcare services as well as all groups of the services.

3.9.1 Costs and benefits used for healthcare services

3.9.1.1 Hospital

Costs used for an analysis covered labor cost, operation and maintenance cost, and impact cost from incinerator stack emission, such as, healthcare cost of local population illness, income loss of local population illness, and environmental damage cost. The benefit estimated from saving healthcare cost and income loss from using on-site incineration. For some hospitals, using on-site incineration was benefited from saving cost of off-site transportation and disposal. Off-site incineration could benefit in saving working hour of waste worker. Benefit was also occurred from saving environmental damage from using incinerator equipped with emission control technology, such as, central incinerator.

3.9.1.2 Health center

Costs of HCW management in health centers covered labor cost, operation and maintenance cost, impact costs from using open burning, and impact costs from open dumping. For open burning, impact costs covered healthcare cost of local population illness, income loss from local population illness, and cost of environmental damage from pollution emission. Impact costs from open dumping also covered healthcare cost of local population illness, income loss from local population illness and cost of environmental damage from pollution.

Benefits of HCW management in health centers included benefits of local population in saving healthcare cost and income loss from illness when some health center transferred HCW to hospitals in stead of using open burning or open dumping. Transferring HCW to hospital for central incineration could minimize air pollution and benefit in saving environmental damage. In case of using open burning, it could benefit in saving off-site transportation and disposal cost.

3.9.1.3 Clinic

Costs of HCW management in clinics included labor cost, operation and maintenance cost, healthcare cost of local population illness from using open burning and dumping to dispose HCW, income loss of local population illness from using open burning and dumping to dispose HCW, cost of environmental damage from pollutions of open burning and dumping. For benefits, using methods of transferring HCW to hospital for incineration or using central incineration directly could benefit for local population in saving healthcare cost and income loss from illness of open burning or dumping. Transferring HCW to hospital for central incineration or using central incineration directly could minimize air pollution and benefit in saving environmental damage.

3.9.2 Costs and benefits used for Yala central HCW incinerator

Although the incinerator and vehicle in the project received a non-profit funding, this study analyzed two scenarios with and without investment cost. Operation costs covered costs of labor, electricity, water supply, incinerator fuel, waste vehicle fuel, maintenance of incinerator and vehicle, and worker protective equipment and training. Benefit of the incinerator was income from HCW transportation and disposal service.

3.9.3 Benefit-cost ratio calculation

Benefit-cost ratio was net benefit divided by net cost of the same scenario. Net cost was a summation of all costs within the same period. For net benefit, a summation of all benefit occurred at that period was done.

3.9.4 Methods of costs estimation

3.9.4.1 Labor cost

Labor cost estimated from waste worker income per hour, working day in a year, and working hour related to HCW per day.

3.9.4.2 On-site management cost

Costs covered red bag, bin, cart, storage room, detergents and disinfectants, personal protective equipments, staff training, on-site incineration and ash disposal. The costs of on-site incineration and ash disposal were for the hospitals used on-site incinerator.

3.9.4.3 Off-site management cost

Management cost covered costs of HCW transportation and incineration at the off-site incinerator.

3.9.4.4 Healthcare related cost of local population illness

Healthcare cost covered medical related and transportation cost. Medical related cost calculated from the study of the Health System Research Institute. Data of the Pattani Hospital, located in the same region and had similar population, was selected, for example, cost for outpatient was 205 Baht/visit, and cost for inpatient was 5,638 Baht/case. For travel costs, data of Yala provincial office was used as reference. Cost of travel in the same sub-district was 40 Baht/trip, for inter-subdistrict within the same district was 80 Baht/trip. Inter-district travel cost used data of public transportation in Yala Province, the average rate was 120 Baht/trip (range 60 Baht/trip to 180 Baht/trip). Based on treatment seeking pattern in Pattani Province in 2006, 42% of patients used health center or other healthcare service within sub-district, 48% used community hospital, and 10% used provincial hospital.

Numbers of local people illness estimated from type of HCW disposal. In case of transferring HCW to hospital, cases estimation based on incineration. Boundaries of the study were varies from emission sources. Impact boundary for HCW combustion was five kilometers radius for rural area but covered the municipal population in urban area. Population data used for cases estimation were the Yala provincial office data in 2006 and 2007 [100-101]. Thirty six percent of the Yala Province population was dependences in both 2006 and 2007. In-patient case was 15% of the out-patient cases. An average length of stay for in-patient was 2.6 days.

3.9.4.4.1 Combustion

Combustion covered both incineration and open burning or dump fired. Respiratory disease was considered as a significant health problem related to air pollution emission for short-term evaluation. Based on a study of Lopez [102], risk to respiratory disease in community closed to the incinerator was 1.79 fold of a comparative community. Example for estimating healthcare related costs from HCW combustion shown in Appendix D.

3.9.4.4.2 Open dump

For the boundary of infectious diseases spread from open dump, the villages located within two kilometers from dumpsite were concerned as high-risk group [103]. Based on a study of Khan [103] five diseases significantly related to waste dumping were selected, including acute respiratory infections, skin infections, fever, eye infections and diarrhea. Assumption, prevalence of five selected diseases increased 30% in high-risk areas. Example for calculating healthcare related costs from open dump shown in Appendix E.

For health data reports, the prevalence of selected diseases in Yala province [100-101] per 100,000 in 2007 and 2008 were as follows:

Disease	**Prevalence**	
	2007	2008
Acute respiratory infections	36,052.16	36,559.16
Skin infections	8,323.57	8,236.38
Fever	502.67	907.20
Eye infections	357.14	446.98
Diarrhea	2,075.08	1,468.22

3.9.4.5 Income loss of local people due to illness

Income loss of local people illness comprised of income loss from stop working for caring others and sick leave. In case of no income data, labor cost estimated from minimum wage in Yala province, 146 Baht/day was used. Based on population data of Yala Province, 36% of population were independent in both 2006 and 2007. Numbers of local villagers' illness from section 9.4.4 were used to estimate in-patient cases and the in-patients who were dependent. For more detail, see Appendix F.

The following formula was used to estimate income loss:

$$IL = ILC + ILW$$

IL	=	Income loss of local people due to illness
ILC	=	Income loss from stop working for caring others
ILW	=	Income loss due to sick leave

3.9.4.6 Environmental damage cost

Cost of environmental damage estimated from carbon price for global warming effect. The global warming effect estimated from climate-relevant CO_2 (CO_2-equivalent). The carbon price estimated from a fixed price of €39t/CO_2-equivalent (CO_2e) or 2053.74 Baht/t CO_2 e (currency equivalent in 30 June 2008, €1.00 = ฿52.66) [104].

Equation for calculating CO_2e was as follows:

Emissions in CO_2e i [kg CO_2]

= Emission i [kg emission] x GWP i [kg CO_2/kg emission]

Where:

Emission i [kg emission] = Emission factor of i x waste volume (kg)

i = CO_2, CO , NMVOC, NO_x, CH_4, PM

The global warming potential (GWP) of i was as follows [105-106]:

i	**GWP (kg CO2/kg emission)**
CO_2	1
CO	3
NMVOC	11
NO_x	8
CH_4	21
PM	680

Emission factors guided by the EPA [106-110] were applied. Open burning and landfill or dump fired caused similar emission [111]. For on-site incineration (hospital incinerator), emission data for un-control starve air incineration was used. Emission data of rotary kiln incinerator with wet scrubber and fabric filter were applied for estimating impact of central HCW incinerator, which have similar model [105, 107-110]. CO_2 generation from HCW burning or incineration was figured out as an average value of 0.415 kg of CO_2 per kg of waste. Wet scrubber equipped in central incinerator could reduce ten percent of CO_2 emission [105]. Emission factor selected for estimation based on recommendation, Table 3.1 [106-110].

Table 3.1 Criteria emission factors for selecting activities

Disposal	**CO_2 (g/kg)**	**CO (g/kg)**	**SO_2 (g/kg)**	**PM (g/kg)**	**NO_x (g/kg)**	**CH_4 (g/kg)**	**NMVOC (g/kg)**
Open burning	415.0	42.0	0.5	8.0	3.0	6.5	15.0
Landfill/dump fired	415.0	42.0	0.5	8.0	3.0	6.5	15.0
Hospital incineration	415.0	1.48	1.09	2.33	1.78	NA	0.15
Central incineration	41.5	$2.50x10^{-2}$	0.15	3.78x10-2	2.45	NA	$2.53x10^{-2}$

Examples for calculating CO_2-equivalent from on-site incineration, central incineration and open burning or dump fired were in Appendix G, H and I, respectively.

3.9.5 Methods of benefits estimation

3.9.5.1 Saved healthcare related cost of local people from using off-site incineration

Similar to healthcare related cost of local people from incinerator stack emission, healthcare related cost of local people from using off-site incineration covered cost of healthcare service and travel cost for healthcare seeking. Formula for calculating saved healthcare related cost of local people from using off-site incineration was as follows:

SC = HC1 – HC2

SC = Saved healthcare related cost of local people illness from using off-site incineration

HC1 = Healthcare related cost of local people illness from using old disposal methods (Baht)

HC2 = Healthcare related cost of local people illness from using new disposal methods (Baht)

3.9.5.2 Saved income loss of local people from using off-site incineration

Method used for estimating saved income loss of local people from using off-site incineration was similar to that from incinerator stack emission. Income loss of local people illness comprised of income loss from stop working for caring others and from sick leave. Formula for calculating saved healthcare related cost of local people from using off-site incineration was as follows:

SIL = SIL1 – SIL2

SIL = Saved income loss of local people illness from using off-site incineration

SIL1 = Income loss of local people illness from old disposal methods (Baht)

SIL2 = Income loss of local people illness from using new disposal method (Baht)

3.9.5.3 Saved labor cost when changed to off-site incineration

Labor cost was used from survey data. Three years of data were collected, a year before baseline phase, baseline phase and operation phase. Saved labor cost was estimated from cost of a previous year – cost of present year.

3.9.5.4 Saved environmental damage from using incinerator with emission control equipment (central incinerator)

Saved environmental damage from using incinerator with emission control equipment (SED) calculated by comparing environmental damage from incinerator stack emission of on-site incineration and central HCW incineration. Following formula was used to calculate saved environmental damage.

SED = EO – EC

SED = Saved environmental damage from HCW combustion

EO = Environmental damage from using old disposal method

EC = Environmental damage from using new disposal method

3.9.5.5 Saved healthcare cost of local people from changing open burning to transferring to hospital for central incineration

Saved healthcare related cost of local people from changing from open burning to transferring to hospital for central incineration was as follows:

SCO = HCO1 – HCO2

SCO = Saved healthcare related cost of local people illness from changing open burning/dumping to central incineration

HCO1 = Healthcare related cost of local people illness from using open burning (Baht)

HCO2 = Healthcare related cost of local people illness from central incineration (Baht)

3.9.5.6 Saved environmental damage from changing from open burning and dump fired to central incineration

Saved environmental damage from changing disposal methods from open burning and dump fired to transferring to hospital for central incineration (SOD) calculated by comparing environmental damage from open burning and dump fired and central HCW incineration. Following formula was used to calculate save environmental damage from changing disposal methods from open burning and dump fired to transferring to hospital for central incineration:

. SOD = EO – EC

SOD = Saved environmental damage from changing from open burning and dump fired to central incineration

EO = Environmental damage from using open burning and dump fired

EC = Environmental damage from using central incineration

3.10. Protection of participants

The Ethical Committee of the Faculty of Tropical Medicine, Mahidol University has approved this study since March 2006. The data collection and analysis process were conducted after the ethical approval. For participants approach, the research team explained research purpose of the study to all participants. Then, they were informed that it was their right to participate or not participate this study.

Whatever they decided would not affect them in any aspect. If they decided to participate, a consent form (Appendix J) was read to them and asked them to sign. All participants were informed that the information obtained remained confidential.

CHAPTER IV
RESULTS

This chapter covers both secondary and primary information related to local communities and healthcare services.

4.1 Local community

4.1.1 Primary data

The study area covered four villages: Ban Prama and Ban Nibongbaru, in Satang-Nok Subdistrict, Muang Yala District; Ban Bukaelangor in Wang Phaya Subdistrict, Raman District; and Ban Tontamsao in Khao Toom Subdistrict, Yarang District. There were 314 respondents (84.4%) at the baseline phase, and 14 respondents dropped out in construction and operation phases, so, 300 respondents (80.6%) participated in three rounds of data collection.

4.1.1.1 Characteristics of respondents

The characteristics of respondents in baseline phase were similar to that of in construction and operation phases. About 58% of them were heads of household, 60% were male, and 75.0% were Muslim. About 44% of them completed primary school level and half of them were laborers. Respondents who were in non-income generating group at baseline, construction and operation phases were 18.2%, 15.7% and 13.3%, respectively.

Proportion of villagers who received information about HCW incinerator project increased from 10.2% at the baseline to 68.0% at the construction phase and then to 87.7% at the operation phases (Table 4.1). In the average household, there were of five members, 1.3 school children and, 1.8 independents. Rate of unemployed was 8.1% (73 persons).

Table 4.1 Socio-demographic information of participants from local community in baseline, construction and operation phases

Item	Baseline N=314		Construction N=300		Operation N=300	
	n	%	n	%	n	%
Head of household						
Yes	183	58.3	173	57.7	173	57.7
No	131	41.7	127	42.3	127	42.3
-Relationship with the head						
-Wife	87	27.7	86	28.7	86	28.7
-Son or daughter	34	10.8	32	10.6	32	10.6
-Others	10	3.2	9	3.0	9	3.0
Sex						
Male	192	61.1	181	60.3	181	60.3
Female	122	38.9	119	39.7	119	39.7
Religion						
Islam	236	75.2	225	75.0	225	75.0
Buddhism	78	24.8	75	25.0	75	25.0
Education						
No formal education	41	13.1	36	12.0	36	12.0
Primary school level	139	44.3	134	44.7	133	44.3
Secondary/high school level	75	23.9	74	24.7	75	25.0
Vocational school level	29	9.2	27	9.0	26	8.7
Graduated level or higher	30	9.6	29	9.7	30	10.0
Occupation						
Laborer	154	49.0	157	52.3	160	53.3
Merchant or business owner	54	17.2	55	18.3	57	19.0
Agriculture(Rubber/Fruit/Vegetable orchard owner)	32	10.2	27	9.0	27	9.0
Teacher	13	4.1	12	4.0	14	4.7
Others	4	1.3	2	0.7	2	0.7
Non-income generated occupation	57	18.2	47	15.7	40	13.3
Receiving detail information about HCW incinerator project						
Yes	32	10.2	204	68.0	263	87.7
No	282	89.8	96	32.0	37	12.3

4.1.1.2 Health facilities

Respondents visited Satang-Nok Health center decreased from 46.7% at the baseline to 40.3% at the construction phase, and to 32.3% at the operation phase (p=0.002). The proportions of those who attended Yala hospital at baseline, construction and operation phases were similar (48.7%, 48.7% and 45.0% respectively, Table 4.2). Comparison between two phases showed similar results (Appendix K).

There were 28 respondents attending the Satang-Nok health center in all three phases. Most respondents satisfied with Satang-Nok health center's providers in the baseline, construction and operation phases (89.3%, 96.4% and 89.3% respectively). Most respondents also reported not many patients in Satang-Nok health center in the baseline, construction and operation phases (92.9%, 85.7% and 96.4% respectively). Similarly, most respondents reported short waiting time for service at the health center and conveniently traveled to the health center in all three phases (Table 4.3). The results were similar to comparisons of two phases (Appendix L).

Of the 41 respondents who attended Yala hospital in all three phases, most of them satisfied with the Yala hospital's provider in the baseline, construction and operation phases (73.2%, 87.8% and 80.5%, respectively). However, most respondents reported many patients at Yala hospital in baseline, construction and operation phases (97.6%, 97.6% and 78.0%, respectively). They also reported long waiting time in the Yala hospital. Most respondents said they conveniently transported to the hospital in all baseline, construction and operation phases (78.0%, 65.9% and 58.7%, respectively, Table 4.4). Similar results were found in comparisons of two phases (Appendix L).

Table 4.2 Villagers' accessibility to healthcare services

Item	Baseline N=300		Construction N=300		Operation N=300		P^{χ}
	n	%	n	%	n	%	
Visit Satang-Nok health center							
Yes	140	46.7	121	40.3	97	32.3	
No	160	53.3	179	59.7	203	67.7	0.002
Visit Yala hospital							
Yes	146	48.7	146	48.7	135	45.0	
No	154	51.3	154	51.3	165	55.0	0.583

$^{\chi}$ = Chi-square test

Table 4.3 Villagers' opinion toward Satang-Nok health center

Item	Baseline N=28		Construction N=28		Operation N=28		P^{Co}
	n	%	n	%	n	%	
Satisfaction with provider							
Yes	25	89.3	27	96.4	25	89.3	0.368
No	3	10.7	1	3.6	3	10.7	
Number of patient							
Many	2	7.1	4	14.3	1	3.6	0.465
Fair	26	92.9	24	85.7	27	96.4	
Waiting time							
Long	6	21.4	3	10.7	3	10.7	0.438
Short	22	78.6	25	89.3	25	89.3	
Transportation							
Convenience	27	96.4	25	89.3	22	78.6	0.066
Inconvenience	1	3.6	3	10.7	6	21.4	

^{Co}= Cochran's Q test

Table 4.4 Villagers' opinion toward Yala hospital

Item	Baseline N=41		Construction N=41		Operation N=41		P^{Co}
	n	%	n	%	n	%	
Satisfaction with provider							
Yes	30	73.2	36	87.8	33	80.5	0.204
No	11	26.8	5	12.2	8	19.5	
Number of patient							
Many	40	97.6	40	97.6	32	78.0	0.001
Fair	1	2.4	1	2.4	9	22.0	
Waiting time							
Long	31	75.6	35	85.4	31	75.6	0.344
Short	10	24.4	6	14.6	10	24.4	
Transportation							
Convenience	32	78.0	27	65.9	24	58.5	0.130
Inconvenience	9	22.0	14	34.1	17	41.5	

^{Co}= Cochran's Q test

4.1.1.3 Safe water

Sources of drinking water included commercial bottle water, shallow well, deep well and tap water. Only one household drank rain water in construction phase. The main source of villagers' drinking water was tap water. Proportion of drinking tap water increased from baseline phase (59.3%) to construction phase (71.3%) but decreased to 69.7% in operation phase. Similar trend of drinking commercial bottle water increased from baseline phase (3.3%) to construction phase (10.7%) and operation phase (16.0%). While, the rate of drinking deep well water decreased from baseline phase (14.0%) to construction phase (11.0%) and operation phase (5.0%), and similar pattern found in proportion of drinking shallow well water ($p<0.001$, Table 4.5). Comparison of the sources of drinking water showed significant difference of sources between baseline and construction phases, baseline and operation phases, and construction and operation phases ($p < 0.05$, Appendix M).

Regarding sources of water supply, three sources were found: tap water, deep well water and shallow well water. Main source of water supply was the tap water and deep well water was in the second rank (Table 4.5). A comparison of water supply sources between baseline and construction phases was significantly different (p=0.031), while comparing the sources between baseline and operation phases, and construction and operation phases were similar (p> 0.06, Appendix M).

Table 4.5 Villagers' accessibility to water in baseline, construction and operation phases

Item	Baseline N=300		Construction N=300		Operation N=300		P^{χ}
	n	%	n	%	n	%	
Sources of drinking water							
Tap water	178	59.3	214	71.3	209	69.7	<0.001
Deep well water	42	14.0	33	11.0	15	5.0	
Shallow well water	40	13.3	20	6.7	28	9.3	
Commercial bottle water	10	13.3	32	10.7	48	16.0	
Rain water	0	0.0	1	0.3	0	0.0	
Sources of water supply							
Tap water	202	67.3	229	76.3	227	75.7	0.066
Deep well water	62	20.7	50	16.7	50	16.7	
Shallow well water	34	11.3	21	7.0	23	7.7	
Rain water	2	0.7	0	0.0	0	0.0	

$^{\chi}$ = Chi-square test

4.1.1.4 Road activities and transportation

Respondents who reported daily walking along village road slightly decreased from 44.0% at baseline to 41.0 % at construction phase and to 37.3% at operation phase (Table 4.6). Frequencies of walking along village road between baseline and construction phases, and construction and operation phases were not different (p > 0.3). However, frequencies of walking along village road between baseline and operation phases was significantly different (p=0.026, Appendix N). The respondents who reported daily cycling along village road in a month at construction phase (22.3%) slightly increased from baseline phase (21.4%) but decreased to 15.3% at operation phase (p=0.012, Table 4.6). Frequencies of cycling along village road between baseline and operation phases was similar, but between baseline and operation phases, and construction and operation phases were significantly different (p=0.016 and p=0.035 respectively, Appendix N).

Motorcycle was the main vehicle used in the local communities. Respondents who reported daily rode motorcycle at baseline, construction and operation phases were 58.3%, 66.0% and 57.7%, respectively (p=0.116, Table 4.6). Frequencies of motorcycle riding between baseline and construction phases, baseline and operation phases, and construction and operation phases were also similar (Appendix N). Frequencies of daily used automobile slightly decreased from 17.4% at baseline phase to 15.3% at construction phase and to 9.0% at operation phase (p=0.061, Table 4.6). Similar results found in two phases comparison, exception between baseline and operation phases (p=0.025, Appendix N).

One hundred and fifty respondents, who walked along village road in all phases, reported that there were many vehicles during walking along village road at baseline, construction and operation phases (38.6%, 41.3% and 23.3%, respectively; p< 0.001). Most respondents also reported a lot of dust during walking along village road, in baseline (60.7%), construction (64.7%) and operation (63.3%) phases (p =0.725). The respondents who reported the village road not clean increased from 64.0% at baseline phase to 76.0% at construction phase, then decreases to 60.0% at operation phase (p=0.005). Proportions of respondent who reported the damage of village road increased from 54.0% at baseline phase to 70.0% at construction phase and to 75.3% at operation phase (p<0.001). Rate of respondent who reported loud noise during walking along village road increased from 43.3% at baseline phase to 64.0% at construction phase but decreased to 22.7% at operation phase (p<0.001, Table 4.7). The comparisons between baseline and construction phases; baseline and operation phases; and construction and operation phases regarding number of vehicle, dust, road cleanness and road surface during walking along village road were significantly different (p < 0.02, Appendix O).

Thirty respondents reported cycling along village road at baseline, construction and operation phases (Table 4.8). Most respondents reported not many vehicle during cycling along village road in baseline, construction and operation phases (63.3%, 56.7% and 70.0%, respectively, p=0.424). More than half of respondents reported a lot of dust during cycling along village road in all baseline, construction and operation phases (63.3%, 53.3% and 53.3%, respectively, p=0.589). Respondents who said the village road did not clean decreased from 60.0% at baseline phase to 56.7% at construction phase and to 46.7% at operation phase ($p=0.846$). Respondents' opinions regarding road surface and noise during cycling along village road were also not different ($p>0.2$). Comparative opinions between baseline and construction phases; baseline and operation phases; and construction and operation phases with respect to number of vehicle, dust, road cleanness, road surface and noise were not different ($p > 0.08$, Appendix O)

Two hundred and fourteen respondents reported riding motorcycle along village road in baseline, construction and operation phases. The respondents who reported the village road did not have many vehicles during riding motorcycle significantly differed between baseline, construction and operation phases ($p=0.028$). Proportions of respondent who reported the village road were not clean increased from 63.6% at baseline phase to 77.6% at construction phase and decreased to 61.7% at operation phase ($p<0.001$). Broken village road increased significantly from baseline to construction and to operation phases ($p<0.001$). Respondents who reported loud noise during riding motorcycle along village road increased from 43.9% at baseline phase to 55.6% at construction phase, then decreased to 28.5% at operation phase ($p< 0.001$, Table 4.9). The comparative opinions toward number of vehicle, road cleanness, road surface, and noise between baseline and construction phases; baseline and operation phases; and construction and operation phases were also different ($p < 0.05$, Appendix O).

There were 77 respondents rode automobile in baseline, construction and operation phases. Their opinions toward number of vehicle during riding automobile along village road were not different in baseline, construction and operation phases ($p= 0.257$). However, respondents who reported much dust during riding automobile increased from 53.2% at baseline phase to 71.4% at construction phase, then decreased to 62.3% at operation phase ($p=0.047$). Similarly, respondents who reported the road were not clean, the broken road and the road had loud noise increased from baseline phase to construction phase, but decreased in operation phase ($p<0.001$, Table 4.10). Comparative opinions towards road cleanness, road surface and noise during using automobile along village road between baseline and construction phase; baseline and operation phases; and construction and operation phases were also significantly different ($p<0.05$, Appendix O).

The average daily traffics were 3,424 PCU at baseline phase, 4,712 PCU at construction phase, and 3,142 PCU at operation phase. A comparative types of vehicle found in baseline, construction and operation phases was significantly different ($p<0.001$). There was 44.9% of motorcycle found at baseline phase, and decreased to 34.5% at construction phase, then increased to 55.2% at operation phase. While, 30.4% of vehicle was pick-up at baseline phase and increased to 34.1% at construction phase, and then decreased to 22.7% at operation phase. Truck was 6.6% of vehicle found at baseline phase, increased to 12.6% at construction phase, and decreased to 8.7 % at operation phase (Table 4.11). Types of vehicles were also significantly different between two phases comparison: that in baseline and construction phases; construction and operation phases; and baseline and operation phases ($p <0.001$, Appendix P).

Table 4.6 Villagers' road activities

Item	Baseline N=300		Construction N=300		Operation N=300		P^{χ}
	n	%	n	%	n	%	
Frequency of walking along village road							
None	59	19.6	81	27.0	88	29.3	0.123
1-2 times	71	23.6	61	20.3	57	19.0	
3-4 times	33	11.1	30	10.0	41	13.7	
>5 times but not daily	5	1.7	5	1.7	2	0.7	
Daily	132	44.0	123	41.0	112	37.3	
Frequency of cycling along village road							
None	147	49.0	167	55.7	185	61.7	0.012
1-2 times	61	20.3	47	15.7	39	13.0	
3-4 times	27	9.0	16	5.3	29	9.7	
>5 times but not daily	1	0.3	3	1.0	1	0.3	
Daily	64	21.4	67	22.3	46	15.3	
Frequency of riding motorcycle along village road							
None	46	15.3	36	12.0	40	13.3	0.116
1-2 times	52	17.4	42	14.0	45	15.0	
3-4 times	20	6.7	20	6.7	37	12.3	
> 5 times but not daily	7	2.3	4	1.3	5	1.7	
Daily	175	58.3	198	66.0	173	57.7	
Frequency of riding car along village road							
None	128	42.7	130	43.3	158	52.7	0.061
1-2 times	79	26.3	73	24.3	75	25.0	
3-4 times	31	10.3	35	11.8	30	10.0	
> 5 times but not daily	10	3.3	16	5.3	10	3.3	
Daily	52	17.4	46	15.3	27	9.0	

$^{\chi}$ = Chi-square test

Table 4.7 Opinion toward road activities among the respondents who walked along village road

Item	Baseline N=150		Construction N=150		Operation N=150		P [Co]
	n	%	n	%	n	%	
Number of vehicle							
Many	58	38.6	62	41.3	35	23.3	<0.001
Fair	92	61.4	88	58.7	115	76.7	
Dust							
Much	91	60.7	97	64.7	95	63.3	0.725
Fair	59	39.3	53	35.3	55	36.7	
Road cleanness							
Clean	54	36.0	36	24.0	60	40.0	0.005
Not clean	96	64.0	114	76.0	90	60.0	
Road surface							
Broken	81	54.0	105	70.0	113	75.3	<0.001
Fair	69	46.0	45	30.0	37	24.7	
Noise							
Loud	65	43.3	96	64.0	34	22.7	<0.001
Fair	85	56.7	54	36.0	116	77.3	

[Co]= Cochran's Q test

Table 4.8 Opinion toward road activities among the respondents who rode bicycle along village road

Item	Baseline N=30		Construction N=30		Operation N=30		P [Co]
	n	%	n	%	n	%	
Number of vehicle							
Many	11	36.7	13	43.3	9	30.0	0.424
Fair	19	63.3	17	56.7	21	70.0	
Dust							
Much	19	63.3	16	53.3	16	53.3	0.589
Fair	11	36.7	14	46.7	14	46.7	
Road cleanness							
Clean	12	40.0	13	43.3	14	53.3	0.846
Not clean	18	60.0	17	56.7	16	46.7	
Road surface							
Broken	19	63.3	19	63.3	20	66.7	0.946
Fair	11	36.7	11	36.7	10	33.3	
Noise							
Loud	17	56.7	13	43.3	10	33.3	0.201
Fair	13	43.3	17	56.7	20	66.7	

[Co]= Cochran's Q test

Table 4.9 Opinion toward road activities among the respondents who rode motorcycle along village road

Items	Baseline N=214		Construction N=214		Operation N=214		P [Co]
	n	%	n	%	n	%	
Number of vehicle							
Many	76	35.5	82	38.3	59	27.6	0.028
Fair	138	64.5	132	61.7	155	72.4	
Dust							
Much	123	57.5	136	63.6	137	64.0	0.273
Fair	91	42.5	78	36.4	77	36.0	
Road cleanness							
Clean	78	36.4	48	22.4	82	38.3	<0.001
Not clean	136	63.6	166	77.6	132	61.7	
Road surface							
Broken	135	63.1	150	70.1	173	80.8	<0.001
Fair	79	36.9	64	29.9	41	19.2	
Noise							
Loud	94	43.9	119	55.6	61	28.5	<0.001
Fair	120	56.1	95	44.4	153	71.5	

[Co]= Cochran's Q test

Table 4.10 Opinion toward road activities among the respondents who rode automobile along village road

Item	Baseline N=77		Construction N=77		Operation N=77		P [Co]
	n	%	n	%	n	%	
Number of vehicle							
Many	27	35.1	28	36.4	20	26.0	0.257
Fair	50	64.9	49	63.6	57	74.0	
Dust							
Much	41	53.2	55	71.4	48	62.3	0.047
Fair	36	46.8	22	28.6	29	37.3	
Road cleanness							
Clean	37	48.1	15	19.5	25	32.5	<0.001
Not clean	40	51.9	62	80.5	52	67.5	
Road surface							
Broken	43	55.8	66	85.7	60	77.9	<0.001
Fair	34	44.2	11	14.3	17	22.1	
Noise							
Loud	35	45.5	48	62.3	19	24.7	<0.001
Fair	42	54.5	29	37.7	58	75.3	

[Co]= Cochran's Q test

Table 4.11 Type of vehicles in Ban Prama's main road to the healthcare waste incinerator project

Type of vehicle	Baseline N=1,224		Construction N=1,362		Operation N=1,166		P $^{\chi}$
	n	%	n	%	n	%	
Bicycle	103	8.4	58	4.3	66	5.7	0.001
Motorcycle	550	44.9	470	34.5	644	55.2	
Pick-up	373	30.4	464	34.1	264	22.7	
Car/Van	102	8.3	176	12.9	72	6.2	
Truck	81	6.6	172	12.6	102	8.7	
Public service vehicle	15	1.2	22	1.6	18	1.5	
Average Daily Traffic							
(vehicle)	4,896		5,448		4,664		
(PCU)	3,424		4,712		3,142		

$^{\chi}$ = Chi-square test

4.1.1.5 Religion activity

Respondents who reported going to village mosque daily was 31.0% at baseline phase, the proportions were slightly decreased to 27.7% at construction phase, and to 27.3% at operation phase (p=0.248, Table 4.12). Comparison of religion activities between baseline and construction phases; baseline and operation phases; and construction and operation phases showed no difference (Appendix Q).

Table 4.12 Villagers' attending religion activities

Frequency	Baseline N=300		Construction N=300		Operation N=300		P $^{\chi}$
	n	%	n	%	n	%	
Never	72	24.0	88	29.3	92	30.7	0.248
1-4 times a month	62	20.7	47	15.7	44	14.7	
2-6 days a week	73	24.3	82	27.3	82	27.3	
Daily	93	31.0	83	27.7	82	27.3	

$^{\chi}$ = Chi-square test

There were 153 respondents attending the village mosque in baseline, construction and operation phases. The respondents who reported seeing many villagers in the mosque declined from 48.4% at baseline phase to 26.1% at construction phase, then it rose up to 32.0% at operation phase (p<0.001). Proportions of respondents who reported good air ventilation in the mosque in construction phase less than the baseline and operation phases (p=0.035). More of respondent reported a lot of dust in the mosque in construction phase (35.3%) more than in baseline (39.4%) and operation phases (22.3%, p=0.022). Proportion of respondent who reported a lot of smoke was higher in operation phase (26.1%) than in the baseline and construction phase (p=0.010). Most respondents reported having sufficient drinking water in the mosque. The proportion rose up from baseline phase (83.7%) to construction phase (93.5%), then declined to 82.4% in operation phase (p=0.003). Trend of respondents who reported sufficient water supply rose from the baseline phase to the operation phase (p=0.008, Table 4.13). The comparisons of baseline phase to construction phase; baseline phase to operation phase; and construction phase to operation phase also showed significantly different (p<0.05, Appendix R).

Table 4.13 Opinion regarding religion activities among villagers who attended the village mosque

Item	Baseline N=153		Construction N=153		Operation N=153		P [Co]
	n	%	n	%	n	%	
Number of villagers in the mosque							
Many	74	48.4	40	26.1	49	32.0	<0.001
Fair	79	51.6	113	73.9	104	68.0	
Air ventilation in the mosque							
Good	142	92.8	131	85.6	142	92.8	0.035
Not good	11	7.2	22	14.4	11	7.2	
Dust in the mosque							
Much	45	29.4	54	35.3	34	22.2	0.022
Fair	108	70.6	99	64.7	119	77.8	
Smoke in the mosque							
Much	25	16.3	20	13.1	40	26.1	0.010
Fair	128	83.7	133	86.9	113	73.9	
Drinking water in the mosque							
Sufficient	128	83.7	143	93.5	126	82.4	0.003
Insufficient	25	16.3	10	6.5	27	17.6	
Water supply in the mosque							
Sufficient	118	77.1	127	83.0	135	88.2	0.008
Insufficient	35	22.9	26	17.0	18	11.8	

[Co]= Cochran's Q test

4.1.1.6 Expectation toward HCW incinerator project

Rates of respondents expected job from the HCW incinerator project significantly increased from 7.7% at baseline phase to 14.0% at construction phase and to 26.0% at operation phase ($p<0.001$). The respondent who expected having road to their orchard or workplace also increased from baseline phase to construction phase and to operation phase ($p=0.013$), and similar trend was found in respondents' expectation toward community development ($p<0.001$). Regarding negative expectation, rate of respondent who expected nuisance from bad odor increased from 71.7% in baseline phase to 84.0% in construction phase and slightly decreased to 78.7% in operation phase ($p=0.001$). Expectations toward infective organism rose from 16.3% in baseline phase to 61.7% in construction phase and up to 70.0% in operation phase ($p<0.001$). Expectation toward danger from car traffic was also increased significantly from baseline, construction and operation phases ($p<0.001$, Table 4.14). Similar results found in comparisons of baseline phase to construction phase, baseline phase to operation phase, and construction phase to operation phase. (Appendix S).

Table 4.14 Villagers' expectation from the HCW incinerator project

Item	Baseline N=300		Construction N=300		Operation N=300		P [Co]
	n	%	n	%	n	%	
Job from the project							
Yes	23	7.7	42	14.0	78	26.0	<0.001
No	227	92.3	258	86.0	222	74.0	
Road to orchard/workplace							
Yes	81	27.0	84	28.0	111	37.0	0.013
No	219	73.0	216	72.0	189	63.0	
Lighting at night time							
Yes	87	29.0	86	28.7	110	36.7	0.058
No	213	71.0	214	71.3	190	63.3	
Improvement of community economic							
Yes	60	20.0	71	23.7	76	25.3	0.283
No	240	80.0	229	76.3	224	74.7	
Community development							
Yes	130	43.3	172	57.3	188	62.7	<0.001
No	170	56.7	128	42.7	112	37.3	
Exist source for waste disposal							
Yes	200	66.7	230	76.7	219	73.0	0.022
No	100	33.3	70	23.3	81	27.0	
Clean environment							
Yes	179	59.7	230	76.7	211	70.3	<0.001
No	121	40.3	70	23.3	89	29.7	
Nuisance from bad odor							
Yes	215	71.7	252	84.0	236	78.7	0.001
No	85	28.3	48	16.0	64	21.3	
Lose area for cattle raising							
Yes	30	10.0	23	7.7	31	10.3	0.473
No	270	90.0	277	92.3	269	89.7	
Infective organism when transported waste							
Yes	49	16.3	185	61.7	210	70.0	<0.001
No	251	83.7	115	38.3	90	30.0	
Bad people coming during construction							
Yes	49	16.3	64	21.3	74	24.7	0.040
No	251	83.7	236	78.7	226	75.3	
Danger from car traffic							
Yes	128	42.7	155	51.7	176	58.7	<0.001
No	172	57.3	145	48.3	124	41.3	
Smoke from incinerator							
Yes	237	79.0	245	81.7	242	80.7	0.707
No	63	21.0	55	18.3	58	19.3	
Dust from the traffic							
Yes	161	53.7	172	57.3	194	64.7	0.021
No	139	46.3	128	42.7	106	35.3	
Danger from materials and equipments							
Yes	10	3.3	2	0.7	6	2.0	0.065
No	290	96.7	298	99.3	294	98.0	

[Co]= Cochran's Q test

4.1.1.7 Perception toward HCW incinerator project

Most respondents perceived risk from HCW incinerator in moderate and high levels. The proportion of respondent who perceived high risk increased significantly in operation phase (52.7%) when compare to baseline and construction phase (36.7% and 32.7% respectively, p<0.001, Table 4.15). Comparisons of risk perception between baseline and operation phases; and construction and operation phases were also different (Appendix T).

Table 4.15 Villagers' risk perception toward HCW incinerator project

Item	**Baseline N=300**		**Construction N=300**		**Operation N=300**		**P** $^{\chi}$
	n	**%**	**n**	**%**	**n**	**%**	
Low	9	3.0	4	1.3	6	2.0	<0.001
Moderate	181	60.3	198	66.0	136	45.3	
High	110	36.7	98	32.7	158	52.7	
Mean(S.D.)	26.2(4.7)		26.7(4.3)		25.1(4.4)		

$^{\chi}$ = Chi-square test

4.1.1.8 Experience related to HCW incinerator project

In construction phase, 3% of respondents affected from the HCW incinerator project. Among them, 2.7% disturbed from loud noise, 0.7% from dust, and 0.3% from vehicle. Proportion of respondents affected from the HCW incinerator project increased to 10.3% in operation phase. Of these, 3.3% experienced bad smell, 3.0% affected by the number of vehicles, 2.0% by smoke, 1.6% by loud noise, and 0.3 % reported allergic rhinitis (Table 4.16).

Table 4.16 Experience related to HCW incinerator project in construction and operation phases

Item	Construction N=300		Operation N=300	
	n	**%**	**n**	**%**
Bad smell	0	0.0	10	3.3
Smoke	0	0.0	6	2.0
Loud noise	8	2.7	5	1.6
Vehicles from the project	1	0.3	9	3.0
Dust from the project	2	0.7	0	0.0
Allergic rhinitis	0	0.0	1	0.3
Total	11	3.7	31	10.3

4.1.1.9 Community leaders' opinion

Five community leaders were interviewed in-depth, including two village headers, a religion leader, a teacher from community school, and a representative of Satang-Nok municipality. Opinions of the leaders were summarized as follows:

4.1.1.9.1 Opinion toward the HCW incinerator project

At baseline phase, three leaders favored the project, one objected and another one had neutral opinion. The leaders who favored gave different reasons. One explained that "overall the project was beneficial. HCW disposal facility was important for protecting people from various diseases. Everyone feared of infective organism from HCW. Incineration was a proper method to destroy these harmful organisms. Another one said that he was contacted and informed about the project at the early stage. Some advantages and disadvantages of the project had been discussed before the project started. Selection of project setting was also explained. The other one said the landfill site that closed to them, would be moved out. He added that, nowadays, the landfill site was about 500 meters from the populated community and the school. The HCW incinerator project setting was about three kilometers from that populated community and school.

The leader, who objected with the project, said that villagers experienced serious pollution from the factories nearby the community. The incinerator could add more pollution to the villagers. The HCW incinerator could bring not only infectious diseases but also many toxic chemicals to the community. Six years ago, their community opposed the incinerator project of Yala hospital. The leader who had neutral opinion toward the project explained that the project had both advantage and disadvantage. The most important information to be used for decision-making was detail about smoke from the incinerator. He added that the staff of Yala municipality informed that the selected incinerator had good technology and would not cause smoke.

The leaders' opinion toward the HCW incinerator project still not changed in construction phase. However, all of them put more attention to activities related to the project. In operation phase, four leaders favored the project. A leader, who was neutral, turned to favor the project at this stage. He explained that smoke released from the incinerator during operation was not as much as he expected and it was acceptable. A leader who objected the project at early phase still insisted on his opinion at this phase. He explained that the villagers exposed to more pollution everyday. New source of pollution should not be accepted.

4.1.1.9.2 Impact on villager migration

Two leaders thought that the project would impact on villager migration in baseline phase. They expected that some villagers would move to settle down along a new road, which would be constructed to the plant. Three leaders said that the project could not impact on villager migration because the plant was far from the populated area. There were a few people migrated to the plant setting area. Number of leaders who thought that the project affected villager migration increased to three peoples in construction phase. Of these, two leaders still insisted their opinion in the baseline phase. Another one just turned to decide that the project could impact the migration pattern of the village at this phase. He explained that some villagers planned to settle-down along the road to the plant. In operation phase, four leaders decided that the project could affect villager migration. They observed some new houses settle-down along the new road to the plant after the project operation. A leader who thought it would not affect villager migration explained that number of villagers who moved were not different from the usual.

4.1.1.9.3 Impact on community group and activity

All five leaders mentioned that the project would not affect community group and activity in baseline and construction phases. They explained that groups and activities in the village such as group of health volunteer, group of women leader, mosque committee and Tadeeka School (Islamic study for children) committee would not have any activity related to the project. These groups and their activities were still function whether the project would develop or not. In operation phase, one leader thought the project could impact on community group and activity. He explained that some local workers employed to the project, got higher status in the village. These workers became new leaders that could help villagers to find job in the Yala municipality.

4.1.1.9.4 Impact on local norm and tradition

The leaders did not think the project would affect villagers' norm and tradition. Some local norms and traditions included group praying in the mosque, mouris party (yearly Islamic party), community Islamic study, sunad activity (introduced a boy or a man to become Islamic and had circumcision on his penis), and arsuror cooking (various plants seeding, vegetable and meat were preserved by boiling, stirring and cooked with salt and sugar). They informed that project just provided HCW disposal, it would not affect any beliefs and traditional activities of villagers.

4.1.1.9.5 Impact on land price

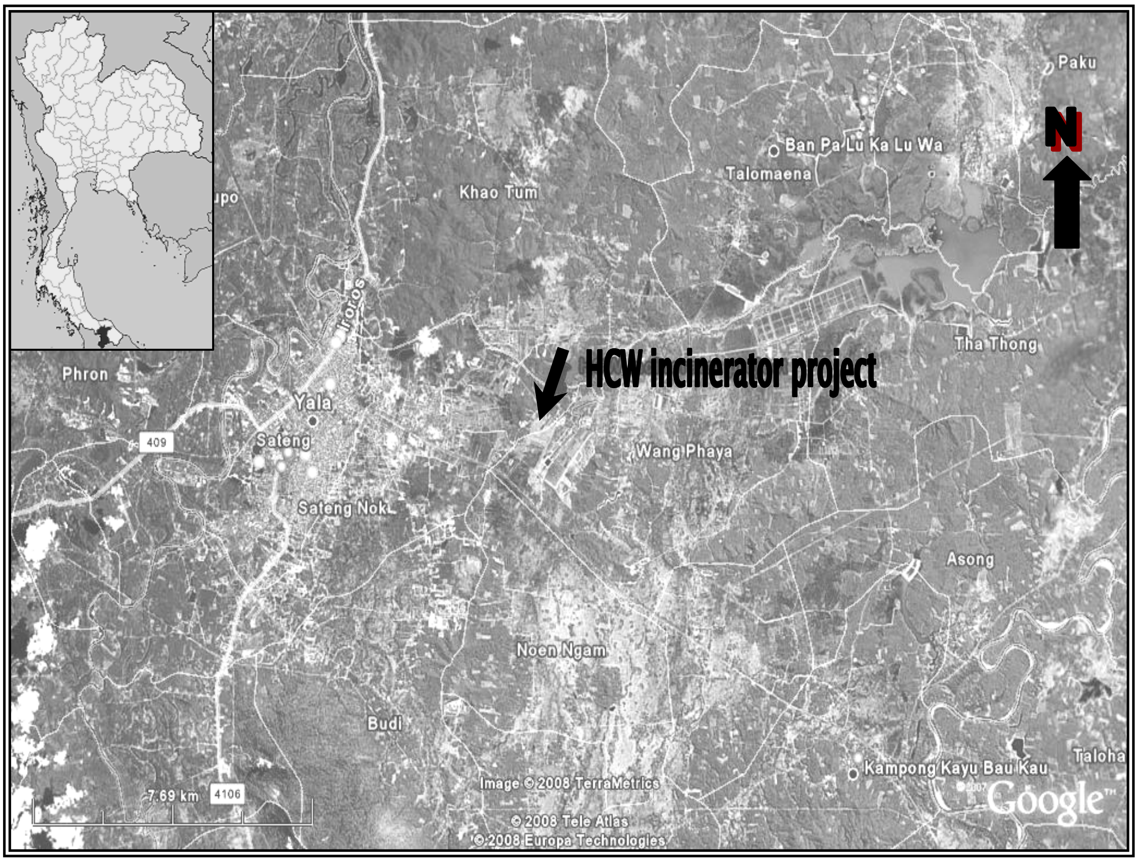
Five leaders mentioned that the project would not affect on land price in baseline. Land price nearby the plant ranged from 30,000 Baht to 80,000 Baht per a piece of 25 square meters. The land closed to road had higher price than that far from the road. Land of fruit or rubber orchards had higher price than that of empty land. In construction phase, one leader implied that the project could influence land price. He mentioned that a new road to the plant had been constructed, so price of land nearby this road would increase. In operation phase, three leaders agreed that land price could be impacted by the project because some houses had settled down along the road to the project. It indicated that the new road could attract villagers because of better transportation.

4.1.1.10 Observation of the HCW incinerator project site

4.1.1.10.1 Planning phase

Location of project setting was observed. There were some cattle raising in the project area. North of the project setting was public forest, fruit orchard in the west, while the east and south surrounded by rubber plantation. There were ten houses located within one kilometer south of the project setting. Five water wells were in the orchards nearby the project setting. The project location was about two kilometers from the village main road.

Figure 4.1 Location of the HCW incinerator project in Yala Province



4.1.1.10.2 Construction phase

It took 12 months for plant construction. Of these, five months were for land clearing and preparation of plant foundation. Other seven months were used to construct a warehouse and assemble the incinerator.

Land clearing and preparation of plant foundation: A tractor was used for 10 working days during land clearing. Loud noise occurred during daytime. Dust produced from this activity was observed. It took three weeks for preparing plant foundation. Noise from foundation piles settled was reported during daytime. Some dust occurred from foundation setting but less than that occurred from the tractor during land clearing. Vibration during foundation setting was reported by some villagers. Fives workers were employed in this period. One worker was from local community. All workers came to work with their own motorcycles. None of them stayed in the plant. The workers exposed to noise and dust that occurred during this period. None of them used personal protective equipment.

Construction of warehouse and incinerator: The incinerator vendor from Bangkok contacted a local construction firm in Yala city to help them construct the warehouse. For incinerator construction, five professional staffs from Bangkok, together with workers from local construction firm worked for a week. There were 25 laborers employed during this construction. However, only one worker employed from local community. Five workers came to work with their own motorcycle. Twenty workers used vehicles provided by their main office in Yala city. There were two pick-up cars carrying workers from the Yala city to the plant at 07.30 am and back at 05.30 pm daily. No worker stayed in the plant during construction. There was no new worker employed from local community during construction.

4.1.1.10.3 Operation period

The HCW incinerator was tested in late September 2007. It started for HCW incineration service in October 2007. At the beginning, six hospitals used the service, and then other four hospitals participated. The Yala city employed four workers to work in the plant. All of them were from local community. Salary of each worker was 6000 Baht per month, about 2,000 Baht higher than their former salaries as unskilled labor. The incinerator operated once a week. A HCW vehicle was provided for HCW collection from participating hospitals. Cost for HCW vehicle fuel was about 4,000 to 5,000 Baht per day. HCW was stored in temperature control room inside warehouse, not more than six days before incineration. There was at least 40 liters of diesel fuel used per operation of incinerator. However, five sets of workers’ protective equipments and 2000 liters of diesel fuel for the incinerator were supported by the incinerator vendor. All workers used protective equipments during work.

4.1.2 Secondary data

4.1.2.1 Socio-demographic characteristics

The populations in Satang-Nok Subdistrict were 25,540 in 2002 and 27,307 in 2008. The population growth rates in 2002 (3.24%) and 2003 (3.20%) were similar, but trend of population growth rates in 2004, 2005 and 2006 decreased (1.61%, 1.10% and -0.08% respectively). Then, the population growth rates increased to 1.58% in 2007 and declined to 1.06% in 2008. The patterns of population growth rates in district level (Mueng District) and provincial level (Yala Province) during 2002 to 2008 were similar to those of Satang-Nok Subdistrict (Table 4.17).

Table 4.17 Population growth rate in selected areas

Areas		2002	2003	2004	2005	2006	2007	2008
Yala Province	P	459,659	465,466	459,868	464,121	468,252	470,691	475,527
	GR	2.96%	3.36%	1.35%	1.43%	0.69%	0.70%	1.25%
Mueng District	P	90,697	92,321	92,819	93,562	94,195	94,213	94,815
	GR	2.02%	1.86%	0.96%	0.78%	0.24%	0.04%	0.77%
Satang-Nok Subdistrict	P	25,540	26,424	26,222	26,479	26,625	27,035	27,307
	GR	3.24%	3.20%	1.61%	1.10%	-0.08%	1.58%	1.06%

P = Total population

GR = Population Growth Rate

Source: Yala Provincial Office

4.1.2.2 Land price

Data from Yala provincial office showed that land price in Yala province, covered the study area had not changed for four years.

4.1.2.3 Community infrastructure and service systems

4.1.2.3.1 Healthcare

There were two main healthcare services in the study area, Satang-Nok health center and Yala hospital. The Satang-Nok health center located about five and a half kilometers from the HCW incinerator project. The Yala hospital was about 12 kilometers from the project. The annual report of Yala public health office in 2007 showed that out-patient and in-patient in the Yala hospital in 2007 decreased 10.6% and 14.3%, respectively, from those of 2006.

4.1.2.3.2 Education

There were three schools located in the study area. Ban Tannampueng school located about 2.5 kilometers west of the project. Ban Bukarbor-ngor school was about 3.5 kilometers north of the project. Daru-uloom school was about five kilometers west of the project. Teacher-student ratios of all three schools during 2005 to 2007 met national standard (teacher: student ≤ 1:25, Table 4.18).

Table 4.18 Number of students and teachers at school nearby the incinerator

School	**2005**			**2006**			**2007**		
	T	S	R	T	S	R	T	S	R
Ban Tannampueng	14	203	1:15	13	188	1:14	13	177	1:13
Daru-uloom	24	384	1:16	28	450	1:16	28	432	1:15
Ban Bukaebor-ngor	15	207	1:17	12	195	1:16	10	201	1:20
Total	**53**	**794**	**1:15**	**53**	**833**	**1:16**	**51**	**810**	**1:16**

T = Teacher

S = Student

R = Ratio of teacher per student

Source: Yala education area office 1

4.1.2.3.3 Water

Data from Satang-Nok Health center showed that, in 2007, coverage of sufficient drinking water in Ban Prama and Ban Nibongbaru were 100% and 99.7 % respectively, and in 2008 they were 100% in both villages.

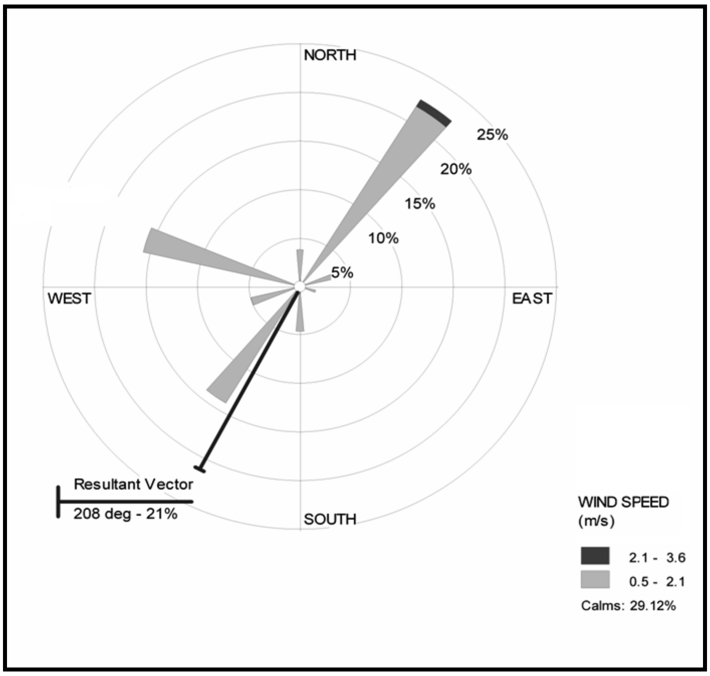
4.1.2.3.4 Transportation

A main road passed the study area (Ban Prama and Ban Nibongbaru) was the road number 1028 or Yala-Toepakae road. There were public vehicles served passengers between Yala city and Ban Toepakae every 30 minutes from 07.00 am to 06.00 pm, every day.

4.1.2.4 Weather

Data from Yala agricultural metrological office between 2005 and 2007 showed that average wind speed was 0.89 meter/second. For wind direction, the wind blew North-East 25%, North-West 16% and South-west 14% (Figure 4.2).

Figure 4.2 Wind rose of Yala Province



4.2 Healthcare facility

There were two rounds of data collection from healthcare facilities, baseline and operation phases. Of the total 142 healthcare facilities in the target area, 129 (90.8%) enrolled in baseline. Two healthcare facilities dropped out in operation phase, a medical clinic closed and a health center temporally closed during second round of data collection. One hundred and twenty seven healthcare facilities (89.2%) participated both baseline and operation phases; including 11 hospitals, 35 medical clinics, nine dental clinics, three veterinarian clinics, and 69 health centers.

4.2.1 Characteristics of provider-respondents

Most respondents in both baseline phase (55.1%) and operation phase (57.5%) were female. Their average ages at baseline and operation phases were 36 years and 37 years respectively. Most of them were Islamic and most hold bachelor degree and above (74.5% and 68.5% respectively) in both baseline and operation phases. Respondents in group of medical doctor/dentist/veterinarian doctor, nurse, other health related staff and non-other health related staff were 18.1%, 17.3%, 47.2% and 17.3%, respectively, in baseline phase; and 11.0%,18.1%, 46.5% and 24.4%, respectively, in operation phase. Most respondent in both baseline and operation phases were responsible in waste management in their office (90.6% and 93.7% respectively). Respondent who had formal training related to waste handling in baseline and operation phase were 62.2% and 63.0% respectively (Table 4.19).

Table 4.19 Characteristics of provider-respondents

Items	Baseline N=127		Operation N=127	
	n	%	n	%
Sex				
Male	57	44.9	54	42.5
Female	70	55.1	73	57.5
Age (years)				
20-39	73	57.5	79	62.2
40-59	52	40.9	48	37.8
60 and above	2	1.6	0	0.0
Mean(Min-Max)	*36*	*(20-70)*	*37*	*(22-59)*
Educational attainment				
Lower than Bachelor degree	32	25.5	40	31.5
Bachelor degree and above	95	74.5	87	68.5
Religion				
Islam	78	61.4	76	59.8
Buddhism	46	36.2	50	39.4
Christ	3	2.4	1	0.8
Profession				
Medical doctor/dentist/veterinarian doctor	23	18.1	14	11.0
Nurse	22	17.3	23	18.1
Other health related staff	60	47.2	59	46.5
Non-health related staff	22	17.3	31	24.4
Responsibility in waste management				
Yes	115	90.6	119	93.7
No	12	9.4	8	6.3
Training in waste management				
Formal training	79	62.2	80	63.0
Self-study from educational materials	27	21.3	20	15.7
No	21	16.5	27	21.3

$^{\chi}$= Chi-square test

4.2.2 HCW generation

4.2.2.1 Hospitals

The 11 hospitals generated HCW 95,181.3 kg/year in baseline phase and 94,626.8 kg/year in operation phase. HCW generation in hospitals was 0.11 kg/patient in both baseline and operation phases (Table 4.20).

4.2.2.2 Health centers

HCW generated from 69 health centers slightly decreased from baseline phase to operation phase (10,183.3 kg/year and 10,086.9 kg/year respectively). HCW generation in health centers was 0.02 kg/patient, similarly, in both baseline and operation phases (Table 4.20).

4.2.2.3 Clinics

Total HCW from 47 clinics increased from 12,939.3 kg/year in baseline phase to 14,879.2 kg/year in operation phase. However, HCW generation in clinic was 0.04 kg/patient, in both baseline and operation phases (Table 4.20).

Table 4.20 HCW generated and number of patients attending hospitals, health centers and clinics

Type of healthcare facilities	Items	Baseline	Operation
Hospitals (N = 11)	Total HCW generated/year (kg)	95,181.3	94,626.8
	Total patient/year (cases)	888,143	895,490
	HCW generated/patient (kg)	0.11	0.11
Health centers (N = 69)	Total HCW generated/year (kg)	10,183.3	10,086.9
	Total patient/year (cases)	473,616	467,613
	HCW generated/patient (kg)	0.02	0.02
Clinics (N = 47)	Total HCW generated/year (kg)	12,939.3	14,879.2
	Total patient/year (cases)	349,660	345,852
	HCW generated/patient (kg)	0.04	0.04

4.2.3 HCW management

4.2.3.1 Hospitals

The HCW from all 11 hospitals segregated in red bag in baseline phase and continued to do in operation phase. Nine hospitals stored their HCW by using closed storage room at baseline phase, and then increased to ten hospitals at operation phase. For HCW disposal, seven hospitals used Hat Yai incinerator at baseline phase while another four hospitals used on-site incinerators. In operation phase, ten hospitals used the Yala HCW incinerator, another one hospital still used on-site incinerator ($p<0.001$), Table 4.21).

Table 4.21 Healthcare waste management in hospitals

Items	Baseline N=11		Operation N=11		P^{Mc}
	n	%	n	%	
HCW segregation					
Separated in red bag	11	100.0	11	100.0	NA
HCW storage					
Closed bin without storage room	2	18.2	1	9.1	>0.999
Closed bin with storage room	9	81.8	10	90.9	
HCW disposal					
Hospital incinerator	4	36.4	1	9.1	<0.001
Central incinerator	7[a]	63.6	10[b]	90.9	

NA = Not applicable

^{Mc} = McNemar test

[a]= Hat Yai incinerator

[b]= Yala incinerator

4.2.3.2 Health centers

All 69 health centers collected HCW separately in red bag in both baseline and operation phases. Proportions of health center that stored HCW in closed bin were 56.5% in baseline phase, and 66.7% in operation phase. The health centers that disposed HCW by open burning slightly decreased from baseline phase (69.6%) to operation phase (60.9%). Similarly, the health center that transferred HCW to local government for land dump decreased from 17.4% at baseline phase to 13.0% at operation phase. However, the health center that transferred HCW to hospital increased from 13.0% at baseline phase to 26.1% at operation phase (Table 4.22).

Table 4.22 Healthcare waste management in health centers

	Baseline N=69		**Operation N=69**		$\mathbf{P}^{Mc}$
	n	**%**	**n**	**%**	
HCW segregation					
Separated in red bag	69	100.0	69	100.0	NA
HCW storage					
Closed bin	39	56.5	46	66.7	0.221
Opened bin	30	43.5	23	33.3	
HCW disposal					
Transfer to local government for land dumping	12	17.4	9	13.0	0.147
Transfer to hospital for incineration/ open burning	57	82.6	60	87.0	

NA = Not applicable

^{Mc} = McNemar test

4.2.3.3 Clinics

Among the group of medical, dental and veterinarian clinics, 32% separated HCW by using red bag at baseline phase, and then increased to 77% at operation phase. Most clinics stored HCW by using closed bin in both baseline phase (91.5%) and operation phase (93.6%). The clinics that transferred HCW to local government for land dumping rapidly decreased from 68.1% at baseline phase to 23.4% at operation phase. In the opposite way, clinics that transferred HCW to hospital rapidly increased from baseline phase to operation phase (17.0% and 31.9% respectively). In operation phase, 44.7% of clinics used Yala incinerator to dispose their HCW (Table 4.23).

Table 4.23 Healthcare waste management in clinics

Items	Baseline N=47		Operation N=47		P^{Mc}
	n	**%**	**n**	**%**	
HCW segregation					
Separated in red bag	15	31.9	36	76.6	<0.001
Mixed with general waste	32	68.1	11	23.4	
HCW storage					
Closed bin	43	91.5	44	93.6	>0.999
Open bin/room	4	8.5	3	6.4	
HCW disposal					
Transfer to local government for land dumping	38	80.9	11	23.4	<0.001
Transfer to hospital for incineration/open burning/ central incinerator[b]	9	19.1	36	76.6	

^{Mc} = McNemar test

[b]= Yala incinerator

4.2.4 Cost of healthcare waste management

4.2.4.1 Hospitals

Labor cost and transportation cost in hospitals decreased from baseline phase to operation phase ($p < 0.05$). Bag cost significantly increased from baseline phase to operation phase (p=0.016). Similarly, cost of disposal increased from 20,640 Baht in baseline phase to 24,320 Baht in operation phase (p=0.019). Total cost of HCW management in hospitals significantly decreased from 279,600 Baht to 198,960 Baht (p<0.001, Table 4.24).

Table 4.24 Costs of HCW management in hospitals

Items	**Cost/year (Baht)**		**P^w**
	Baseline N=11	**Operation N=11**	
Labor			
Mean	105,039	72,890	0.043
(Min-Max)	(48,000-252,000)	(48,000-114,000)	
Segregation/ storage			
Mean	23,706	22,174	0.123
(Min-Max)	(8,400-35,625)	(,8400-38,600)	
Transportation/disposal			
Mean	224,240	202,446	0.110
(Min-Max)	(6,600-1,499,290)	(7,209-1,571,900)	
Safety materials/ worker training			
Mean	16,793	16,623	0.180
(Min-Max)	(4,200-233,450)	(7,290-28,250)	
Total			
Mean	392,626	349,668	0.033
(Min-Max)	(95,950-1,617,215)	(90,500-1,689,600)	

^{w} = Wilcoxon signed rank test

4.2.4.2 Health centers

Costs of HCW management in health centers regarding labor, bag, transportation, disposal, disinfectants, training and PPE were similar between baseline and operation phases. Total costs of HCW management in baseline phase (568 Baht/year) and operation phase (565 Baht/year) were also similar (Table 4.25).

Table 4.25 Costs of HCW management in health centers

Items	Cost/year (Baht)		P^w
	Baseline N=69	Operation N=69	
Labor			
Mean	299	1,126	0.042
(Min-Max)	(0-7,200)	(0-18,000)	
Segregation/ storage			
Mean	583	542	0.544
(Min-Max)	(70-2,840)	(0-2,840)	
Transportation/disposal			
Mean	268	285	0.952
(Min-Max)	(0-2,880)	(0-3,840)	
Safety materials/ worker training			
Mean	123	36	0.152
(Min-Max)	(0-2,400)	(0-1,200)	
Total			
Mean	1,419	1,989	0.653
(Min-Max)	(70-11,748)	(70-18,380)	

^{w} = Wilcoxon signed rank test

4.2.4.3 Clinics

In group of medical, dental and veterinarian clinics; labor cost increased from baseline phase to operation phase (p=0.035). Similarly, costs of bag, and transportation significantly increased from baseline phase to operation phases (p<0.05). However, cost of disposal significantly decreased from baseline phase to operation phase (p=0.012). Total cost of HCW management in clinics increased significantly from 2,785 Baht in baseline phase to 13,140 Baht in operation phase (p=0.008, Table 4.26).

Table 4.26 Costs of HCW management in clinics

Items	Cost/year (Baht) Baseline N=47	Cost/year (Baht) Operation N=47	P^w
Labor			
Mean	1,861	8,497	<0.001
(Min-Max)	(0-14,400)	(0-18,000)	
Segregation/ storage			
Mean	889	1,248	0.023
(Min-Max)	(0-9,600)	(0-4,800)	
Transportation/disposal			
Mean	845	1,812	<0.001
(Min-Max)	(0-2,800)	(360-6,740)	
Safety materials/ worker training			
Mean	1,197	1,360	0.729
(Min-Max)	(0-12,000)	(0-7,100)	
Total			
Mean	4,793	12,918	<0.001
(Min-Max)	(0-24,000)	(1,200-29,540)	

^{w} = Wilcoxon signed rank test

4.2.5 Opinions toward HCW management

4.2.5.1 Hospitals

The respondents from hospitals implied that their staff did proper segregation of HCW in both baseline and operation phase. Similarly, they did proper on-site HCW transportation and disposal methods in both baseline and operation phase. More than half said that costs of red bag, off-site HCW transportation and disposal were fair (Table 4.27).

Table 4.27 Waste handlers' opinion toward HCW management in hospitals

Items	Baseline N=11		Operation N=11		P
	n	%	n	%	
HCW segregation					
Proper	11	100.0	11	100.0	NA
On-site HCW transportation					
Proper	11	100.0	11	100.0	NA
Methods of HCW disposal					
Proper	11	100.0	11	100.0	NA
Cost of HCW red bag					
Fair	8	72.7	9	81.8	>0.999^{F}
High	3	27.3	2	18.2	
Cost of off-site HCW transportation					
Fair	6	54.5	8	72.7	0.659$^{\chi}$
High	5	45.5	3	27.3	
Cost of HCW disposal					
Fair	6	54.5	8	72.7	0.659$^{\chi}$
High	5	45.5	3	27.3	

NA = Not applicable
^{F} = Fisher exact test
$^{\chi}$ = Chi-square test

4.2.5.2 Health centers

All respondents from health centers thought that they did proper HCW segregation in both baseline and operation phases. Most of them (96.7%) also thought that they did proper on-site transportation in both baseline and operation phases. More than half thought they had proper methods for HCW disposal. Most respondents thought that cost of red bag was fair (Table 4.28).

Table 4.28 Waste handlers' opinion toward HCW management in health centers

Item	Baseline N=69		Operation N=69		P
	n	%	n	%	
HCW segregation					
Proper	69	100.0	69	100.0	NA
On-site HCW transportation					
Proper	67	97.1	67	97.1	>0.999^{F}
Improper	2	2.9	2	2.9	
Methods of HCW disposal					
Proper	46	66.7	43	62.3	0.593$^{\chi}$
Improper	23	33.3	26	37.7	
Cost of HCW red bag					
Fair	64	92.8	67	97.1	0.441^{F}
High	5	7.2	2	2.9	
Cost of off-site HCW transportation					
Fair	33	47.8	31	44.9	0.583$^{\chi}$
High	0	0.0	1	1.4	
Not applicable	36	52.2	37	53.6	
Cost of HCW disposal					
Fair	29	42.0	28	40.6	>0.999$^{\chi}$
Not applicable	40	58.0	41	59.4	

NA = Not applicable
^{F} = Fisher exact test
$^{\chi}$ = Chi-square test

4.2.5.3 Clinics

Among the group of medical/dental/veterinarian clinics, opinions toward proper handle of HCW segregation increased from 34.0% at baseline phase to 76.6% at operation phase (P <0.001). Proportion of respondents who thought the cost of HCW disposal was fair decreased significantly from baseline phase to operation phase (p=0.032, Table 4.29).

Table 4.29 Waste handlers' opinion toward HCW management in clinics

Item	Baseline N=47		Operation N=47		P $^{\chi}$
	n	%	n	%	
HCW segregation					
Proper	16	34.0	36	76.6	<0.001
Improper	31	66.0	11	23.4	
On-site HCW transportation					
Proper	47	100.0	47	100.0	NA
Methods of HCW disposal					
Proper	40	85.1	43	91.5	0.521
Improper	7	14.9	4	8.6	
Cost of HCW red bag					
Fair	40	85.1	32	68.1	0.056
High	7	14.9	11	23.4	
Not applicable	0	0.0	4	8.5	
Cost of off-site HCW transportation					
Fair	38	80.9	32	68.1	0.083
High	8	17.0	11	23.4	
Not applicable	1	2.1	4	8.5	
Cost of HCW disposal					
Fair	39	83.0	29	61.7	0.032
High	8	17.0	18	38.3	

NA = Not applicable

$^{\chi}$ = Chi-square test

4.3 Cost-benefit analysis

4.3.1 Cost benefit analysis of healthcare services

4.3.1.1 Hospitals

4.3.1.1.1 Costs

A.1-1 Baseline phase

A.1-1.1 Labor: 26 workers work on HCW management in 11 hospitals and annual labor cost was 1,158,400 Baht.

A.1-1.2 On-site management: four hospitals used on-site incinerators, and on-site management cost was 890,740 Baht.

A.1-1.3 Off-site management: seven hospitals used Hat Yai central HCW incinerator, about 150 kilometers from Yala city. Annual cost of HCW management was 2,268,747 Baht in this phase.

A.1-1.4 Healthcare related cost of local population illness:

1) Four on-site incinerations affected on 26,521 local people. There were 7,551 cases of respiratory disease occurred from incinerator stack emission. Therefore, healthcare cost from the cases of respiratory disease was 7,701,579 Baht. Related travel cost for healthcare seeking was 188,169 Baht. Healthcare related cost of local people illness from on-site stack emission was 7,720,448 Baht.

2) Seven hospitals used Hat Yai central HCW incinerator. Local populations nearby the Hat Yai central incinerator were 11,375 persons. Rate of respiratory diseases in Song Khla province was 39.43%. There were 3,543 cases of respiratory disease due to the HCW incineration. The healthcare related cost of local population illness from using Hat Yai central incineration was 3,701,826 Baht. Because total HCW incinerated at Hat Yai central HCW incinerator was 547,500 kg and 13.8% (75,628 kg) was from seven hospitals.

Healthcare related cost of local population illness from Hat Yai central incineration occurred from seven hospitals = 3,701,826 Baht X 13.8/100 = 510,851 Baht

Therefore, healthcare related cost of local population illness

= 7,720,448 Baht + 510,851 Baht

= 8,231,293 Baht

A.1-1.5 Income loss of local people due to illness:

1) Based on 7,551 cases of respiratory disease due to four on-site incinerator stack emission in A.1-1.4, 1), 2,718 cases were dependent and 4,833 cases were independent. Income loss from stop working for caring others (ILC) was 491,252 Baht Income loss from sick leave (ILW) was 874,686 Baht.

Income loss of local people illness (IL) from on-site incineration

= ILC + ILW

= 491,252 Baht + 874,686 Baht

= 1,366,628 Baht.

2) Seven hospitals used Hat Yai central

HCW incineration: based on 3,543 respiratory cases estimated, 2,267 cases were independent and 1,276 cases were dependent. Income loss from stop working for caring others (ILC) was 231,007 Baht Income loss from sick leave (ILW) was 410,392 Baht.

Income loss of local people illness from using central incineration (IL)

= ILC + ILW

= 231,007 Baht + 410,932 Baht

= 641,399 Baht

Because proportion of HCW from seven hospitals was 13.8% of total HCW incinerated at Yat Yai central HCW incinerator, income loss of local population illness due to HCW from seven hospitals

= 641,399 Baht X 13.8/100

= 88,513 Baht

Therefore, income loss of local people illness due to incineration

= 1,366,628 Baht + 88,513 Baht

= 1,455,141 Baht

A.1.1-6 Environmental damage from incinerator stack emission

. Calculation of environmental damage from stack emission comprised of emission from 22,875 kg of HCW from four hospitals using on-site incinerators and 75,628 kg of HCW from seven hospitals using Hat Yai HCW central incinerator. The CO_2- equivalent generated from HCW on-site incineration from four hospitals was 37.74 ton, and that generated from HCW of seven hospitals incinerated by Hat Yai central HCW incinerator was 3.21 ton. Total CO_2-equivalent generated from HCW incineration was 40.95 ton.

Environmental damage = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€

= 40.95 x 39 x 52.66 Baht

= 84,100 Baht

A.1-2 Operation phase

A.1-2.1 Labor: number of workers reduced to 24 after three hospitals used Yala central HCW incinerator instead of on-site incinerator. Annual labor cost decreased to 1,055,000 Baht.

A.1-2.2 On-site management: one hospital used on-site incinerator and annual on-site management costs decreased to 485,850 Baht.

A.1-2.3 Off-site management: seven hospitals that ever used Hat Yai central HCW incinerator turned to use Yala central HCW incinerator. Three hospitals that ever used on-site incinerator in baseline phase changed to use the Yala central HCW incinerator. Totally, ten hospitals used Yala central HCW incinerator. Annual cost of off-site HCW management increased to 2,738,050 Baht.

A.1-2.4 Healthcare related cost of local population illness: people affected by HCW incinerator stack emission decreased to 13,598 after Yala central HCW incinerator and an on-site incinerator were used. Cases of respiratory diseases from incinerator stack emission decreased to 3,927. Healthcare cost and travel cost for healthcare seeking were 4,005,689 Baht and 81,286 Baht, respectively. Total healthcare related cost of local people illness from stack emission was 4,086,975 Baht.

A.1-2.5 Income loss of local people due to illness

Cases of respiratory disease estimated were 3,927, comprised of 1,414 cases in group of dependent and 2,513 cases of independent population. Estimated income loss from stop working for caring others (ILC) was 301,478 Baht Income loss from sick leave (ILW) was 536,065 Baht. Total income loss of local population illness in operation phase was 837,544 Baht.

A.1-2.6 Environmental damage from incinerator stack emission

. Based on data that one hospital used on-site incinerator and 10 hospitals used Yala central HCW incinerator, 2,080 kg of HCW were incinerated on-site and 107,621 kg of HCW were incinerated by Yala central HCW incinerator. CO_2- equivalent generated from on-site incineration was 3.43 ton, and that of Yala central HCW incineration was 4.75 ton. Totally, CO_2-equivalent generated in this phase was 8.18 ton.

Environmental damage = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€

= 8.18 x 39 x 52.66 Baht

= 16,799 Baht

4.3.1.1.2 Benefits

A.2-1 Baseline phase

A.2-1.1 Saved healthcare related cost of local people from using off-site incineration

There were seven hospitals used Hat Yai central HCW incinerator in this phase.

Scenario I: seven hospitals still used on-site incinerator. There were 130,344 people living nearby seven on-site incinerators. Cases of respiratory disease occurred from stack emission were 37,124. Cost of healthcare service was 37,864,158 Baht. Travel cost for healthcare seeking was 249,470,213 Baht. Totally, healthcare related cost of local population illness from using on-site incinerator (HC1) was 287,334,372 Baht.

Scenario II: Seven hospitals used Hat Yai central HCW incinerator. Based on section A.1-1.4, Total healthcare related cost of local people illness from using Hat Yai central incineration was 3,701,826 Baht. Because proportion of HCW from seven hospitals was 13.8% of HCW incinerated, healthcare related cost (HC2) due to HCW from seven hospitals was 510,851 Baht

Therefore,

Saved healthcare related cost of local populations illness from using off-site incineration (SC) in baseline phase = HC1-HC2

= 287,334,372 Baht – 510,851 Baht

= 286,823,521 Baht

A.2-1.2 Saved income loss of local populations' illness from using off-site incineration

Scenario I: seven hospitals still used on-site incineration: based on 37,214 respiratory cases, 13,397 were dependent and 23,817 were independent patients. Income loss for caring others was 2,051,043 Baht and for sick leave was 3,646,403 Baht. Therefore, income loss of local people illness from using on-site incineration (SIL1) was 5,697,446 Baht.

Scenario II: seven hospitals used Hat

Yai central HCW incineration: based on section A.1-1.5, scenario II, income loss of local people illness (SIL2) due to HCW from seven hospitals incinerated at Hat Yai central HCW incinerator was 88,513 Baht.

Therefore, Saved income loss of local populations illness from using off-site incineration (SIL) in baseline phase = SIL1-SIL2

= 5,697,446 Baht – 88,513 Baht

= 5,608,933 Baht

A.1-1.3 Saved labor cost when changed to off-site incineration: based on seven hospitals using Hat Yai central HCW incineration, labor cost reduced 106,200 Baht from using on-site incineration.

A.1-1.4 Saved environmental damage from using incinerator with emission control equipment (central incinerator): The calculation based on 75,628 kg of HCW generated from seven hospitals.

Scenario I: seven hospitals used on-site incineration. Of the 75,268 kg of HCW incinerated, total CO_2- equivalent generated was 124.8 ton. Environmental damage from using on-site incineration (EO) was 256,236 Baht.

Scenario II: seven hospitals used Hat Yai central HCW incineration. Total CO2- equivalent generated reduced to 3.2 ton. Environmental damage from using central incineration (EC) was 6,596 Baht.

Therefore, environmental damage from using incinerator with emission control equipment (central incinerator) = EO – EC

= 256,236 Baht – 6,596 Baht

= 249,640 Baht

A.2-2 Operation phase

A.2-2.1 Saved healthcare related cost of local people from using off-site incineration: there were ten hospitals using Yala central HCW incinerator.

Scenario I: ten hospitals still used on-site incineration. People living nearby ten on-site incinerators were 149,749. Cases of respiratory disease from ten on-site incinerator stack emission were 43,125. Cost of healthcare service was 44,112,951 Baht and travel cost for healthcare seeking was

290,640,749 Baht. Total healthcare related cost of local population illness from on-site incinerators stack emission (HC1) was 334,753,700 Baht.

Scenario II: ten hospitals used Yala central HCW incineration. The Yala central HCW incinerator affected 1,318 local people. Estimated cases of respiratory disease were 381. Cost of healthcare service of local population illness from Yala central HCW incinerator was 388,255 Baht. Travel cost for healthcare seeking was 25,580 Baht. Healthcare related cost of local people from using Yala central HCW incineration (HC2) was 413,836 Baht. Because total HCW incinerated by Yala central HCW incinerator was 107,621 kg and 88.0% (94,627 kg.) was from ten hospitals, healthcare related costs due to HCW from ten hospitals

= 413,836 Baht X 88.0/100

= 364,176 Baht

Therefore, saved healthcare related cost of local people illness from using off-site incinerator (SC) in operation phase = HCI – HC2

= 334,753,700 Baht-364,176 Baht

= 333,389,524 Baht

A.2-2.2 Saved income loss of local people illness from using off-site incineration

Scenario I: ten hospitals still used on-site incineration. Based on 43,125 respiratory cases estimated, 15,525 cases were dependence and independent cases were 27,600. Income loss from stop working for caring others was 2,316,173 Baht. Income loss from sick leave was 4,117,667 Baht. Income loss of local people illness from using on-site incineration (SIL 1) was 6,433,840 Baht.

Scenario II: ten hospitals used Yala central HCW incineration. Based on 381 respiratory cases estimated, 137 cases were dependence and 244 cases were independence. Income loss from stop working for caring others was 24,831 Baht. Income loss from sick leave was 44,150 Baht. Income loss of local people illness from using Yala central HCW incineration (SIL 2) was 68,982 Baht. Based on 88.0% of HCW incinerated was from ten hospitals, income loss due to HCW from ten hospitals = 68,392 Baht X 88.0/100

= 60.185 Baht

Therefore, Saved income loss of local people illness from using off-site incineration (SIL) in baseline phase = SIL1-SIL2

= 6,433,840 Baht – 60,185 Baht

= 6,373,655 Baht

A.2-2.3 Saved labor cost when changed to off-site incineration: ten hospitals using Yala central HCW incinerator, saved labor cost 138,800 Baht.

A.2-2.4 Saved environmental damage from using incinerator with emission control equipment: HCW generated from ten hospitals that used Yala central (98,996 kg) was used for calculation.

Scenario I: ten hospitals used on-site incineration. Total CO_2- equivalent generated was 163.3 ton and environmental damage from using on-site incineration (EO) was 335,409 Baht.

Scenario II: ten hospitals used Yala central HCW incineration. Total CO2- equivalent generated was 4.2 ton and cost of environmental damage (EC) was 8,635 Baht.

Therefore, environmental damage from using incinerator with emission control equipment (central incinerator) saved 326,775 Baht.

4.3.1.1.3 Summary costs, benefits and benefit-cost ratio of HCW management in hospitals

Net cost in baseline was 14,088,154 Baht and reduced to 9,220,218 Baht in operation phase. Most costs decreased from baseline to operation phases, excepted cost of off-site management increased from 2,268,747 Baht in baseline phase to 2,738,050 Baht in operation phase. Net benefits increased from 292,788,294 Baht in baseline phase to 340,228,754 Baht in operation phase. Most benefit occurred from saving illness of local populations after used off-site incinerators instead of the on-site incinerators. The benefit-cost ratio in baseline phase was 20.8, while in operation phase it increased to 36.9 (Table 4.30).

Table 4.30 Cost-benefit analysis of HCW management in hospital

Items	Baseline	Operation
Costs per year (Baht)		
Labor	1,158,400	1,055,000
On-site management	890,740	485,850
Off-site management	2,268,747	2,738,050
Healthcare related cost of local population illness from incinerator stack emission	8,231,299	4,086,975
Income loss of local population illness from incinerator stack emission	1,455,141	837,544
Environmental damage from incinerator stack emission	84,100	16,799
Net costs	**14,088,154**	**9,220,218**
Benefits per year (Baht)		
Saved healthcare related cost of local populations from using off-site incineration	286,823,521	333,389,524
Saved income loss of local populations from using off-site incineration	5,608,933	6,373,655
Saved labor cost when changed to off-site incineration	106,200	138,800
Saved environmental damage from using incinerator with emission control technology (central incinerator)	249,640	326,775
Net benefits	**292,788,294**	**340,228,754**
Benefit-cost ratio	**20.8**	**36.9**

4.3.1.2 Health centers

4.3.1.2.1 Costs

B.1-1 Baseline phase

B.1-1.1 Labor: Annual labor cost in baseline phase was 19,002 Baht.

B.1-1.2 On-site management: 48 health centers disposed by open burning, which had annual management cost 57,053 Baht.

B.1-1.3 Off-site management: 12 health centers transferred HCW to local government for open dump and nine health centers transferred HCW to the hospitals making annual cost of management as 17,280 Baht.

B.1-1.4 Healthcare related cost of local population illness from using open burning: people affected by open burning were 66,595. Cases of respiratory disease were 18,967. Estimated cost for healthcare service was 19,345,452 Baht and 472,659 Baht for travel cost for healthcare seeking. Total healthcare related cost of local population illness from using open burning was 19,818,111 Baht.

B.1-1.5 Income loss of local people illness from using open burning: estimated 18,967 cases of respiratory disease occurred, 6,828 cases were dependent and 12,139 cases were independent population. Income loss from stop working for caring others (ILC) was 1,091,984 Baht Income loss from sick leave (ILW) was 1,941,408 Baht. Therefore, income loss of local people was 3,033,392 Baht.

B.1-1.6 Healthcare related cost of local people illness from transferring HCW to local government for open dump: Populations affected by open dump were 15,011. Cases of five diseases related were 2131. Estimated cost for healthcare service was 2,713,043 Baht and travel cost for healthcare seeking was 143,172 Baht making cost as 2,316,016 Baht.

B.1-1.7 Income loss of local people illness from transferring HCW to local government for open dump: based on 2,131 cases estimated, 767 cases were in dependent group and 1,364 cases were in independent group. Income loss from stop working for caring dependent patient (ILC) was 207,056 Baht Income loss from sick leave (ILW) was 368,204 Baht. Total income loss in baseline phase was 575,260 Baht.

B.1-1.8 Healthcare related cost of local people illness from transferring HCW to hospitals for using Hat Yai central HCW incinerator. Based on 3,701,826 Baht of healthcare related cost of local people from Hat Yai central HCW incinerator and proportion of HCW from nine health centers incinerated at Hat Yai central HCW incinerator was 0.3%, healthcare related cost from the health centers was:

= 3,701,826 Baht X 0.3/100

= 11,105 Baht

B.1-1.9 Income loss of local people illness from transferring HCW to hospitals for using Hat Yai central HCW incinerator

Based on 641,399 Baht of income loss of local people from Hat Yai central HCW incinerator and 0.3% of HCW incinerated was from nine health centers, income loss of local people illness from HCW of nine health center was

= 641,399 Baht X 0.3/100

= 1,924 Baht

B.1-1.8 Environmental damage from HCW open burning: There were 6,913 kg of HCW being disposed by open burning and dump fired. The CO_2- equivalent generated was 41.04 ton. HCW incinerated by Hat Yai central HCW incinerator was 1,467 kg, generated CO_2- equivalent equal to 0.6 ton. Total CO_2- equivalent occurred was 41.64 ton.

Environmental damage = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€

= 41.64 x 39 x 52.66 Baht

= 85,518 Baht

B.1-2 Operation phase

B.1-2.1 Labor: Annual labor cost increased to 25,680 Baht.

B.1-2.2 On-site management: 42 health centers disposed HCW by on-site open burning. Annual on-site management costs slightly decreased from that of baseline phase to 56,561 Baht.

B.1-2.3 Off-site management: Nine

health centers still transferred HCW to local government for opened dump. Eighteen health centers transported HCW to the hospitals. Annual cost of off-site HCW management in this phase increased to 34,560 Baht.

B.1-2.4 Healthcare related cost of local people illness from using open burning. Populations affected by open burning in this phase decreased to 60,103. There were 17,359 cases of respiratory disease occurred. Cost of healthcare service decreased to 17,705,097 baht. Travel cost for healthcare seeking was 359,285 Baht. Total healthcare related cost of local population illness from using open burning in this phase was 18,064,383 Baht.

B.1-2.5 Income loss of local people illness from using open burning. Cases of respiratory disease estimated in this phase were 17,359, comprised of 6,249 cases in group of dependent and 11,110 cases in independent. Estimated income loss from stop working to care dependent patient (ILC) was 961,901 Baht, and loss from sick leave (ILW) was 1,710,073 Baht making total income loss 2,671,974 Baht.

B.1-2.6 Healthcare related cost of local people illness from transferring HCW to local government for open dump. People affected by open dump in this phase decreased to 10,228. There were 1,461 cases of selected diseases related to open dump occurred. Cost of healthcare service was 1,490,258 Baht and travel cost was 98,187 Baht. Total healthcare related cost from using open burning was 1,588,445 Baht.

B.1-2.7 Income loss of local people illness from transferring HCW to local government for open dump: cases of five selected diseases related to open dump were 1,461. There were 526 cases were dependent and 935 cases were independent population. Estimated income loss from caring dependent patient (ILC) was 126,319 Baht and from sick leave (ILW) was 224,593 Baht. Total income loss was 350,912 Baht.

B.1-2.8 Healthcare related cost of local population illness from transferring HCW to central HCW incineration. Eighteen health centers transferred HCW to hospital for using Yala central HCW incinerator. Based on total healthcare related cost of local population illness from Yala central incineration (413,836 Baht) and 3.8% of HCW incinerated was from 18 health centers, Healthcare related cost occurred from HCW of 18 health centers was

= 413,836 Baht X 3.8/100

= 15,736 Baht

B.1-2.9 Income loss of local population illness from transferring HCW to central HCW incineration: income loss of local people illness from Yala central HCW incinerator was 68,982 Baht. Income loss fo local people illness from incinerated HCW of the health centers was

= 68,982 Baht X 3.8/100

= 2,621 Baht

B.1-2.10 Environmental damage from HCW open burning. CO_2- equivalent generated by open burning and dump fired in this phase was 32.26 ton, and from Yala central HCW incineration was 0.18 ton. Total CO_2- equivalent generated was 32.44 ton.

Environmental damage = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€

= 32.44 x 39 x 52.66 Baht

= 66,623 Baht

4.3.1.2.2 Benefits

B.2-1 Baseline phase

B.2-1.1 Saved healthcare cost of local people from changing open burning to central incineration: There were nine health centers transferred HCW to hospital for central incineration at Hat Yai central HCW incinerator. All of them used to dispose HCW by on-site open burning.

Scenario I: nine health centers still used on-site open burning. There were 11,416 people affected. Cases of respiratory disease occurred were 3,251. Cost of healthcare service was 3,316,280 Baht. Travel cost for healthcare seeking was 218,495 Baht. Total healthcare related cost from using on-site open burning (HCO1) was 3,534,775 Baht.

Scenario II: Nine health centers transferred HCW to hospital for using Hat Yai central HCW incinerator. Estimated healthcare related cost of local people illness (HCO2) from incinerated HCW of nine health centers by Hat Yai central HCW incinerator was 11,105 Baht.

Therefore, saved healthcare related cost of local populations illness from using off-site incineration (SCO) in baseline phase = HCO1-HCO2

= 3,534,775 Baht – 11,105 Baht

= 3,523,670 Baht

B.2-1.2 Saved income loss of local people from changing open burning/dumping to transferring to hospital for central incineration:

Scenario I: nine health centers used old methods to dispose HCW. Cases of disease related to HCW disposal were 3,251, 1,170 cases were in dependent group were 1,170 and 2,081 cases were in independent group. Income loss for giving care was 265,948 Baht and for sick leave was 472,900 Baht. Therefore, income loss of local population illness from using on-site incineration (SIL1) was 738,848 Baht.

Scenario II: nine health centers transferred HCW to hospitals for incineration at Hat Yai central HCW incinerator and caused income loss (SIL2) of 1,924 Baht.

Therefore, saved income loss of local populations illness from changing open burning/dumping to transferring to hospital for incineration (SIL)

= SIL1-SIL2

= 738,848 Baht – 1,924 Baht

= 736,924 Baht

B.2-1.3 Saved environmental damage from changing disposal methods from open burning and dump fired to transferring to hospital for central incineration: The calculation based on 1,467 kg of HCW from nine health centers that changed disposal method from open burning to central incineration.

Scenario I: HCW disposed by open burning. Of the 1,467 kg of HCW, total CO_2- equivalent generated from its open burning was 8.7 ton. Environmental damage from using on-site incineration (EO) was 17,886 Baht.

Scenario II: HCW were combusted at Hat Yai central HCW incinerator. Total CO2- equivalent generated reduced to 0.06 ton. Environmental damage from using central incineration (EC) was 128 Baht.

Therefore, saved environmental damage from changing disposal methods from open burning and dump to transferring to hospital for central incineration

= EO-EC

= 17,886 Baht - 128 Baht

= 17,758 Baht

B.2-2 Operation phase

B.2-2.1 Saved healthcare cost of local people from changing open burning to central incineration. There were 18 health centers transferred HCW to hospital for Yala central HCW incinerator. Fifteen health centers used to dispose HCW by on-site open burning, people impacted were 17,908. Another three health centers changed from transferring to local government for open dump. There were 4,783 people near by dumping areas.

Scenario I: 18 health centers still used their own methods to dispose HCW.

1) Fifteen health center used on-site open burning to dispose HCW. Based on 17,908 local populations impacted from open burning, 5,121 cases of respiratory disease were estimated. Cost of healthcare service was 5,223,083 Baht and travel cost for healthcare seeking was 344,126 Baht. Total healthcare related cost from open burning was 5,567,209 Baht.

2) Three health centers transferred HCW to local government for open dump. There were 4,783 people impacted by open dump. Cases of diseases related to open dump were 683. Cost of healthcare service was 696,901 Baht and travel cost for healthcare seeking was 45,916 Baht. Total healthcare related cost from open dump was 742,817 Baht.

Total healthcare related cost of local population illness from using open burning/dumping (HCO1) was 6,310,026 Baht.

Scenario II: 18 health centers used Yala central HCW incineration. Estimated cost of local people illness (HCO2) from HCW incinerated by Yala central HCW incinerator was 15,736 Baht.

Therefore, saved healthcare related cost of local population illness from using off-site incinerator (SCO) in operation phase = HCOI – HCO2

= 6,310,026 Baht-15,736 Baht

= 6,294,263 Baht

B.2-2.2 Saved income loss of local populations from changing open burning/dumping to central incineration:

Scenario I: 18 health centers used old methods for HCW disposal. Cases of related disease from open burning were 5,121 and those from open dump were 683. Thus, there were 5,804 cases occurred from old methods of HCW disposal. Of these, 2,089 cases were dependence and independent cases were 3,715. Income loss from stop working for giving care of dependent patient was 400,133 Baht and income loss from sick leave was 711,452 Baht. Income loss of local people illness from using open burning/dumping (SIL 1) was 1,111,586 Baht.

Scenario II: 18 health center transferred HCW to hospital for Yala central HCW incineration. Estimated income loss (SIL2) of local people illness was 2,621 Baht.

Therefore, saved income loss of local populations illness from changing open burning/dumping to transferring to hospital for incineration (SIL) in baseline phase

= SIL1-SIL2

= 1,111,586 Baht – 2,621 Baht

= 1,108,965 Baht

B.2-2.3 Saved environmental damage from changing disposal methods from open burning and dump fired to central incineration: 18 health centers changed disposal methods from open burning and dump to central incineration, and 15 health centers used to dispose HCW by open burning and three used to dispose by open dump. HCW generated from 15 health centers that used to dispose HCW by open burning were 4,128 kg and three health centers used to dispose HCW by open dump were 522 kg. Based on five percent of HCW in dumping site had to be fired, there were 28 kg of HCW fired. Total HCW that being disposed by open burning and dump fired were 4,156 kg.

Scenario I: 18 used old methods for HCW disposal. Of the ten hospitals used on-site incineration 4,156 kg of HCW disposed by open burning and dump fired, total CO_2- equivalent generated was 24.7 ton. Environmental damage from open burning and dump fired (EO) was 50,670 Baht.

Scenario II: 18 health center transferred HCW to Yala central HCW incineration. Total CO2- equivalent generated was 0.18 ton. Environmental damage from using central incineration (EC) was 362 Baht.

Therefore, environmental damage from open burning and dump to transferring to central incineration

= EO – EC

= 50,670 Baht - 362 Baht

= 50,308 Baht

4.3.1.2.1 Summary of costs, benefits and benefit-cost ratio of HCW management in health center

Cost for HCW management occurred in group of health center was 25,934,661 Baht in baseline phase. Most costs, 19,181,111 Baht, were the cost of local people illness related to open burning of HCW. In operation phase, the cost of HCW management reduced to 22,877,495 Baht. Most costs (18,064,383 Baht) were also from the cost of local people illness related to open burning HCW. Net benefit in baseline phase was 4,278,314 Baht. The benefit increased to 7,453,536 Baht in operation phase. Most benefits in both baseline and operation phases were from saving healthcare cost of local people from changing open burning or open dump to central incineration. The benefit-cost ratio in baseline phase was 0.16; it increased to 0.33 in operation phase (Table 4.31).

Table 4.31 Cost-benefit analysis of HCW management in health center

Items	Baseline	Operation
Costs per year (Baht)		
Labor cost	19,002	25,680
On-site management	57,053	56,561
Off-site management	17,280	34,560
Healthcare related cost of local population illness from using open burning	19,818,111	18,064,383
Income loss of local population illness from using open burning	3,033,392	2,671,974
Healthcare related cost of local population illness from transferring HCW to local government for open dump	2,316,016	1,588,445
Income loss of local population illness from transferring HCW to local government for open dump	575,260	350,912
Healthcare related cost of local population illness from central incineration	11,105	15,736
Income loss of local population illness from central incineration	1,924	2,621
Environmental damage from pollution emission	85,518	66,623
Net costs	**25,934,661**	**22,877,495**
Benefits per year (Baht)		
Saved healthcare cost of local populations from changing open burning/dumping to transferring to hospital for central incineration	3,523,632	6,294,263
Saved income loss of local populations from changing open burning/dumping to transferring to hospital for incineration	736,924	1,108,965
Saved environmental damage from changing disposal method from open burning to transferring to hospital for central incineration	17,758	50,308
Net benefits	**4,278,314**	**7,453,536**
Benefit-cost ratio	**0.16**	**0.33**

4.3.1.3 Clinics

4.3.1.3.1 Costs

C.1-1 Baseline phase

C.1-1.1 Labor: annual labor cost was 100,599 Baht.

C.1-1.2 On-site management: only one clinic disposed HCW by on-site opened burning, making annual on-site management cost of 100,178 Baht.

C.1-1.3 Off-site management: 38 clinics used open dump. Eight clinics disposed HCW by incineration, therefore, annual cost of off-site HCW management was 66,105 Baht.

C.1-1.4 Healthcare related cost of local people illness from using open burning: There were 292 kg of HCW from a clinic disposed by open burning in baseline phase. This open burning could affect on 4,400 local populations. Cases of respiratory disease were 1,253, costing healthcare service 1,278,713 Baht. Travel cost for health care seeking was 31,229 Baht. Total healthcare related cost of local people illness from using open burning was 1,309,402 Baht.

C.1-1.5 Income loss of local people illness from using open burning: based on 1,253 cases of respiratory disease, 451 cases were dependent and 802 cases were independent population. Income loss from stop working for taking care of dependent patient (ILC) was 160,933 Baht Income loss from sick leave (ILW) was 286,207 Baht. Therefore, total income loss of illness from using open burning in baseline phase was 447,140 Baht.

C.1-1.6 Healthcare related cost of local population illness from open dump: 38 clinics disposed by open dump at a dump site in Satang-Nok Subdistrict. Population affected by open dump were 1,318. Cases of five diseases related to waste dumping were 187. Estimated cost for healthcare service was 190,798 Baht and that of travel cost for healthcare seeking was 12,571 Baht. Total healthcare related cost of local population illness from open dump was 203,369 Baht.

C.1-1.7 Income loss of local population illness from open dump: based on 187 cases, 67 were cases from dependent group and 120 cases were independent group. Income loss from stop working for caring dependent patient (ILC) was 12,192 Baht and from stop working due to illness (ILW) was 21,451 Baht. Total income loss of local population illness in baseline phase was 33,643 Baht.

C.1-1.8 Healthcare related cost of local people illness from using central incineration. Eight clinics transferred HCW to hospitals for Hat Yai central incineration. Based on 3,701,826 Baht of healthcare related cost estimated and 0.8% (1,855 kg) of HCW was from eight clinics, Healthcare elated cost from HCW of eight clinics incineration was 29,615 Baht.

C.1-1.9 Income loss of local people illness from central incineration. Estimated total income loss of Hat Yai central HCW incinerator was 641,399 Baht. Proportion of HCW from eight clinics incinerated was 0.8%. Therefore, income loss of local people illness from eight clinics' HCW incineration was 5,131 Baht.

C.1-1.10 Environmental damage from HCW combustion: There was 292 kg of HCW disposed by using open burning; 10,792 kg was disposed by at dumping site. Therefore, the HCW dump-fired was 539.6 kg. Amount of HCW used for calculation in this phase was 831.6 kg. The CO_2- equivalent generated from using open burning and dump-fired was 6.6 ton. HCW from eight clinics (1,855 kg), disposed by Hat Yai central incineration, generated 0.08 ton of CO_2- equivalent. Total CO_2- equivalent was 6.68 ton.

Environmental damage = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€
= 6.68 x 39 x 52.66 Baht
= 13,719 Baht

C.1-2 Operation phase

C.1-2.1 Labor: annual labor cost increased to 399,359 Baht.

C.1-2.2 On-site management: none clinic disposed HCW by on-site open burning. However, annual on-site management costs increased to 127,013 Baht after the Yala municipality enforced the regulation of HCW management in Yala municipal area.

C.1-2.3 Off-site management: 11 clinics still used opened dump. Twenty one clinics used HCW transportation and incineration service of the Yala municipality. Fifteen clinic transported HCW to the hospitals. Annual cost of off-site HCW management in this phase increased to 86,482 Baht.

C.1-2.4 Healthcare related cost of local population open dump: People affected by open dump in this phase were 1,339. There were 191 cases of selected diseases related to open dump occurred and caused 195,097 baht of healthcare service. Travel cost for healthcare seeking was 12,854 Baht. Total healthcare related cost of local population illness from using open burning in this phase was 207,951 Baht.

C.1-2.5 Income loss of local people illness from open dump: Of the 191 cases of five selected diseases related to open dump, 69 were in group of dependent and 122 were cases of independent population. Income loss from stop working for caring dependent patient (ILC) was 12,390 Baht and loss from sick leave (ILW) was 22,078 Baht. Total income loss of local population illness from open dump in operation phase was 34,468 Baht.

C.1-2.6 Healthcare related cost of local people illness of central incineration: total healthcare related cost from Yala central HCW incineration was 413,836 Baht. Proportion of HCW from 36 clinics incinerated by Yala central HCW incinerator was 8.2% (8,866 kg). Therefore, healthcare related cost of HCW from the clinics was 33,935 Baht.

C.1-2.7 Income loss of local people illness from central incineration: based on 68,982 Baht of income loss of local people illness estimated from Yala central HCW incinerator and 8.2% of HCW from clinics, total income loss occurred from clinics' HCW central incineration was 5,657 Baht

C.1-2.8 Environmental damage from HCW combustion: No clinic disposed HCW by open burning. There was 1800 kg of HCW disposed by open dump. Therefore, 90 kg of HCW was fired at dumping site and generated 0.72 ton of CO_2- equivalent. Of the HCW incinerated by central incineration was 8,866 kg, 0.38 ton of CO_2- equivalent occurred. Total CO_2-equivalent was 1.1 ton.

Environmental damage = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€

= 1.1 x 39 x 52.66 Baht

= 2,259 Baht

4.3.1.3.2 Benefits

C.2-1 Baseline phase

C.2-1.1 Saved healthcare related cost of local people illness after changing HCW disposal method from open dump to central incineration: eight clinics changed HCW disposal method open dump to central incineration at Hat Yai central incinerator.

Scenario I: eight clinics disposed open dump. Data calculated in section C.1-1.6 was used. Total healthcare related cost of local population illness from transferring HCW of 38 clinics (10,792 kg) for open dump was 203,369 Baht. Proportion of HCW from eight clinics was 21.0% (2,272 kg). Therefore, cost from HCW of eight clinics (HC1) was 42,707 Baht.

Scenario II: eight clinics disposed HCW by Hat Yai central incinerator. There was 3,701,826 Baht of healthcare related cost of local population nearby Hat Yai central HCW incineration illness, and 29,625 baht (HC2) caused by HCW from eight clinics. Therefore, saved healthcare related cost of local population illness (SC) after changing HCW disposal method from transferring to local government for open dump to central incineration

= HC1-HC2

= 42,747 Baht- 29, 625 Baht

= 13,122 Baht

C.2-1.2 Saved income loss of local population after changing HCW disposal method from open dump to central incineration: eight clinics changed HCW disposal method from transferring to local government for open dump to transferring to hospital for central incineration at Hat Yai central incinerator.

Scenario I: Eight clinics disposed HCW by transferring to local government for open dump. Similar to section C.1-1.7, total income loss of local population illness was 33,643 Baht. Proportion of HCW generated from eight clinics was 21.0%. Income loss due to HCW from eight clinics

(SIL1) was 7,065 Baht.

Scenario II: Eight clinics disposed HCW for Hat Yai central HCW incineration. Estimated income loss of local people illness (SIL2) from eight clinics' HCW incineration was 5,131 Baht. Therefore, saved income loss of local people after changing from open dump to central incineration

= SIL1-SIL2

= 7,065 Baht – 5,131 Baht

= 1,934 Baht

C.2-1.3 Saved the environmental damage from changing disposal method from open dump to central incineration: there were 1,855 kg of HCW from eight clinics disposed HCW by central incineration.

Scenario I: eight clinics transferred HCW to local government for open dump. There were 92.7 kg of HCW fired at dump site. CO_2- equivalent generated in this phase was 0.74 ton.

Environmental damage (EO) = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€

= 0.74 x 39 x 52.66 Baht

= 1,518 Baht

Scenario II: Eight clinics transferred HCW to hospital for central incineration. CO_2- equivalent generated was 0.08 ton.

Environmental damage (EC) = CO_2- equivalent (ton) x 39€/ton x 52.66Baht/€

= 0.08 x 39 x 52.66 Baht

= 162 Baht

Therefore, saved environmental damage (SOD) from changing disposal method from open dump to central incineration

= EO - EC

= 1,518 Baht – 162 Baht

= 1, 356 Baht

C.2-2 Operation phase

C.2-2.1 Saved healthcare related cost of local people illness after changing from open burning to central incineration: A clinic that used to dispose HCW by open burning changed to Yala central incineration in operation phase.

Scenario I: one clinic used open burning. Healthcare related cost of local people illness from using open burning (HC1) was 1,309,402 Baht

Scenario II: one clinic used Yala central HCW incineration. There were 1,318 people impacted by Yala central HCW incineration in baseline, and 375 cases of respiratory disease occurred. Healthcare related cost from central incineration was 392,225 Baht. Proportion of HCW from a clinic was 0.2% (183 kg) of HCW incinerated by Yala central HCW incinerator. Therefore, healthcare related cost from HCW of a clinic (HC2) was 785 Baht. Saved health related cost of local people illness (SC) after changing from open burning to central incineration

= HC1 – HC2

= 1,309,402 Baht – 785 Baht

= 1,308,617 Baht

C.2-2.2 Saved income loss of local people after changing from open burning to central incineration:

Scenario I: one clinic used open burning. Income loss due to open burning (SIL1) was 447,140 Baht.

Scenario II: one clinic used Yala central HCW incineration. Cases of respiratory disease (375 cases) in section C.2-2.1were used for calculation. Total income loss of local population illness from using Yala central HCW incineration was 67,890 Baht. Based on 0.2% of HCW incinerated was from the clinic, income loss (SIL2) occurred was 136 Baht. Therefore, saved income loss (SIL) of local people after changing from open burning to central incineration

= SIL1 – SIL2

= 447,140 Baht- 136 Baht

= 447,004 Baht

C.2-2.3 Saved healthcare related cost of local people illness after changing from open dump to central incineration: 36 clinics change from open dump to Yala central incinerator.

Scenario I: 36 clinics disposed HCW by open dump. Similar to section C.1-2.6, healthcare related cost (HC1) of local people illness from open dump was 207,951 Baht.

Scenario II: 36 clinics used Yala central incineration. Total healthcare related cost from local population illness from Yala central HCW incineration was 402,445 Baht. Proportion of HCW from 36 clinics was 8.2%. Healthcare related cost from 36 clinics was 33,000 Baht. Therefore, saved healthcare related cost (SC) of local people illness after changing from open dump to central incineration

= HC1 – HC2

= 207,915 Baht- 33,000 Baht

= 174,915 Baht

C.2-2.4 Saved income loss of local people after changing from open dump to central incineration: 36 clinics change open dump to Yala central HCW incinerator.

Scenario I: 36 clinics disposed HCW by open dump. Similar to section C.1-2.6, income loss due to local people illness (SIL1) from open dump was 33,643 Baht.

Scenario II: 36 clinics used Yala central HCW incineration. Data from C.1-2.7 was used; income loss (SIL2) of local people illness from incinerated HCW from 36 clinics was 5,657 Baht. Therefore, saved income loss of local people after changing open dump to central incineration

= SIL1 – SIL2

= 33,643 Baht- 5,657 Baht

= 27,986 Baht

C.2-2.5 Saved the environmental damage from open burning and dump-fired to central incineration: one clinic changed from open burning to central incineration. Twenty seven clinics changed from open dump to central incineration.

1) Saved environmental damage after changing from open burning to central incineration

Scenario I: Using open burning: environmental damage (EO) due to 183 kg of HCW disposed by open burning was 2,231 Baht.

Scenario II: using central incineration: cost for environmental damage (EC) was 25 Baht.

Saved environmental damage (SED) after changing HCW disposal method from open burning to central incineration

= EO - EC

= 2,231 Baht- 25 Baht

= 2,206 Baht

2) Saved environmental damage after changing from open dump central incineration.

Scenario I: 27 clinics disposed HCW by open dump. Of the 10,918 kg of HCW generated, 545.9 kg were dump fired. CO_2-equivalent generated was 4.35 ton. Cost for environmental damage (EO) was 8,943 Baht.

Scenario II: 27 clinics disposed HCW by central incineration. CO_2-equivalent generated from central incineration of 10,918 kg of HCW decreased to 0.46 ton. Cost for environmental damage (EC) decreased to 952 Baht.

Saved environmental damage (SED) after changing HCW disposal method from transferring to local government for open dump to transferring to hospital for central incineration or used central incineration directly

= EO - EC

= 8,943 Baht – 952 Baht

= 7,991 Baht

Therefore, total environmental damage saved in this phase

= 2,206 Baht + 7,991 Baht

= 210,197 Baht

4.3.1.3.1 Summary of cost, benefits and benefit-cost ratio of HCW management in clinic

Net cost of HCW management in clinics reduced from 2,389,901 Baht in baseline phase to 897,124 Baht in operation phase. Labor cost increased from 100,599 Baht in baseline phase to 399,359 Baht in operation phase. Similarly, healthcare related cost of local population illness from open dump slightly increased from 203,639 Baht in baseline phase to 207,951 Baht in operation phase. Cost of environmental damage from air pollution decreased from 13,719 Baht in baseline phase to 2,259 Baht in operation phase. The benefit-cost ratio showed advantage in operation phase (Table 4.32).

Table 4.32 Cost-benefit analysis of HCW management in clinic

Items	Baseline	Operation
Costs (Baht)		
Labor	100,599	399,359
On-site management	100,178	127,013
Off-site management	66,105	86,482
Healthcare related cost of local people illness from using open burning	1,390,402	0
Income lost of local people illness from using open burning	447,140	0
Healthcare related cost of local people illness from open dump	203,369	207,951
Income lost of local people illness from open dump	33,643	34,468
Healthcare related cost of local people illness from central incineration	29,615	33,935
Income loss of local people illness from central incineration	5,131	5,657
Environmental damage from pollution emission	13,719	2,259
Net costs	**2,389,901**	**897,124**
Benefits (Baht)		
Saved healthcare related cost of local people illness after changing from open burning to central incinerator	0	1,308,617
Saved Income lost of local people illness after changing from open burning to central incinerator	0	447,004
Saved healthcare related cost of local people illness after changing from open dump to central incinerator	13,112	174,915
Saved Income lost of local people after changing from open dump to central incinerator	1,934	27,986
Saved the environmental damage	1,356	10,197
Net benefits	**16,402**	**1,968,719**
Benefit-cost ratio	**0.007**	**2.19**

4.3.2 Cos-benefit of the central HCW incinerator management

4.3.2.1 Scenario I: with investment cost

4.3.2.1.1 Costs

4.3.2.1.1.1 Investment: The project life was 25 years, with 37,2500,000 Baht of investment of incinerator, where house and waste vehicle . Condition factor was 4% decreased, until investment cost became zero in the 25th year. Repayment was also 4% of investment cost. Interest rate was 2% based on the rate of environmental fund in the area. Private discount rate for the project was 2%.

4.3.2.1.1.2 Labor: labor cost covered employment cost of four waste workers and a technician. There was 432,000 Baht in the first year. Based on Yala municipality data, labor cost would increase 1.5% per year.

4.3.2.1.1.3 Electricity and water supply: the project used deep well water, operated by electric power pump. There was 19,805 Baht for the first year of operation. The project expected cost of electricity would increase 5% per year.

4.3.2.1.1.4 Incinerator maintenance: maintenance costs covered cost of periodic check, stack emission test, and incinerator fixed. Maintenance cost in the first year of operation was 42,752 Baht. The project estimated that maintenance cost would increase 10% per year.

4.3.2.1.1.5 Fuel for incinerator and waste vehicle: in the first year, fuel cost was 1,196,600 Baht. In Thailand, trend of diesel fuel prices in average five years increased 1.6%.

4.3.2.1.1.6 Waste vehicle maintenance: Cost in this group covered costs of periodic check, air condition and vehicle fixed. There was 12,650 Baht used of first year. The project also estimated that cost of vehicle maintenance would increase 10% every year.

4.3.2.1.1.7 Chemicals and equipments for waste handler: cost of this group covered costs of detergents, chemicals, and personal protective equipments.

4.3.2.1.1.2 Benefits

4.3.2.1.1.2.1 Income from HCW transportation and disposal service from hospitals: price for HCW transportation and incineration services shown in Table 4.33.

4.3.2.1.1.2.2 Income from HCW transportation and disposal service from clinics: price for HCW transportation and incineration services from the Yala municipality shown in Table 4.33.

Table 4.33 Price for HCW transportation and incineration service

Years	Transportation and incineration		Incineration (Baht/kg)
	Hospitals (Baht/kg)	Clinics (Baht/clinic/month)	
1 - 3	30	150	20
4 - 6	40	180	25
7 - 9	50	220	30
10 - 12	65	260	35
13 and above	80	300	40

4.3.2.2 Scenario I: with investment cost

The Yala HCW incinerator started to operate in October 2007. Investment cost after one-year operation was 35,760,000 Baht. There were 1,196,600 Baht of vehicle and incinerator's fuel costs. Net costs for one year operation were 39,712,007 Baht. Incomes of the project were from HCW transportation and disposal services. Net incomes for one-year operation were 2,620,980 Baht. The benefit–cost ratio of first year was 0.07. At the year of 25th the benefit-cost ratio increased to 2.7. (Table 4.34). Sensitivity analysis showed that if fuel price change the benefit-cost ratio would also dramatically changed. However, if interest rate changed it would not much effect to the benefit-cost ratio (Figure 4.3).

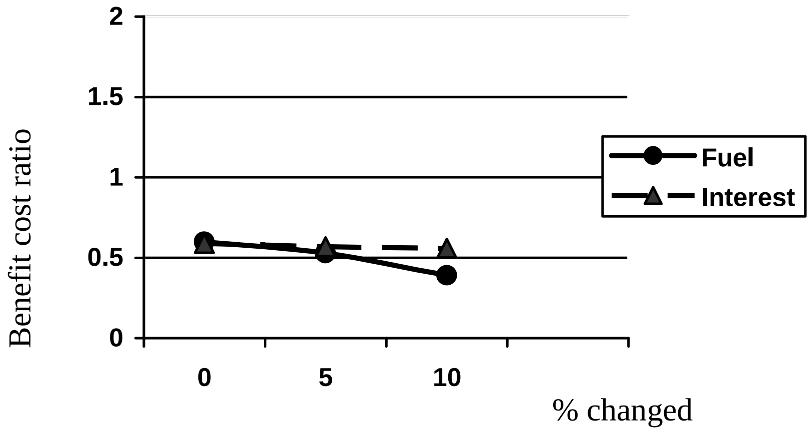
Table 4.34 Costs and benefits of the central HCW incinerator when estimated with investment cost

Items	Factors	Years	
		1	25
Costs (Baht)			
Investment	4.0%*	35,760,000	0
Interest	2%	745000	29800
Repayment	None	1490000	1490000
Labor	1.5%	432,000	617,545
Electricity and water supply	5.0%	19,805	63,873
Incinerator maintenances	10.0%	42,752	421,096
Fuel for incinerator and waste vehicle	1.6%	1,196,600	1,751,451
Waste vehicle maintenances	10.0%	12,650	29,828
Workers' protective equipment	4.2	4,200	11,274
Net cost		39,712,007	4,414,867
Benefits(Baht)			
Income from HCW transportation and disposal service from hospitals	**	2,583,180	12,019,819
Income from HCW transportation and disposal service from clinics in Yala municipality	**	37,800	75,600
Net benefit		2,620,980	12,095,419
Cash flow		-37,082,027	- 4,508,623
Private discount rate	2%	0.98	0.50
Net present value		-36,340,386	-2,254,311
Benefit-cost ratio		**0.07**	**2.7**

* Condition factor for 25 years useful life

** See Table 4.33

Figure 4.3 Sensitivity analysis of Scenario I if fuel price or interest rate were changed



4.3.2.2 Scenario II: without investment cost

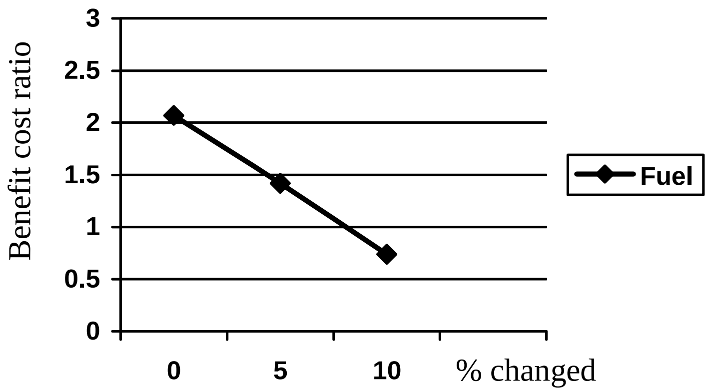
Because this project was sponsored, investment cost could be excluded from an analysis. The results showed that the benefit-cost ratio was up to 1.53 in the first year. Its net present value was 894,713 Baht. In the 25th year, net cost of the project increased to 16,436,900 Baht. While, net benefit was 12,095,419 Baht. Net present value was -2,170,740 Baht. The benefit-cost ratio decreased to 0.94 (Table 4.35). The sensitivity analysis in this scenario was still related with fuel price. Trend of benefit–cost ratio dramatically decreased if increased fuel prices (Figure 4.4).

Table 4.35 Costs and benefits of the central HCW incinerator when estimated without investment cost

Items	Factors	Years	
		1	25
Costs (Baht)			
Labor	1.5%	432,000	617,545
Electricity and water supply	5.0%	19,805	63,873
Incinerator maintenances	10.0%	42,752	421,096
Fuel for incinerator and waste vehicle	1.6%	1,196,600	11,786,190
Waste vehicle maintenances	10.0%	12,650	29,828
Workers' protective equipment	4.2	4,200	11,274
Net cost		1,708,007	12,929,806
Benefits(Baht)			
Income from HCW transportation and disposal service from hospitals	**	2,583,180	12,019,819
Income from HCW transportation and disposal service from clinics in Yala municipality	**	37,800	75,600
Net benefit		2,620,980	12,095,419
Cash flow		912,973	-834,387
Private discount rate	2%	0.98	0.50
Net present value		894,713	-417,193
Benefit-cost ratio		**1.53**	**0.94**

**See Table 4.33

Figure 4.4 Sensitivity analysis of scenario II if fuel price was changed



4.3.3 Social cost-benefit analysis of central HCW incinerator project in Yala province after one year operation

A combination of data in Table 4.30, 4.31, 4.32 and 4.35 were used for analyzing social costs and benefits for Yala province. Two scenarios were summarized, baseline phase and after one year operation. Over all HCW management cost in Yala Province, costs of labor, and operations and maintenances slightly increased from baseline phase to operation phase. However, costs related to healthcare and environmental damage decreased. Net cost decreased from baseline phase (42,221,247 Baht) to operation phase (30,531,251 Baht). Most benefits were from saving healthcare related costs. Net benefits increased from 292,818,386 Baht in baseline phase to 352,575,484 Baht in operation phase. The benefit-cost ratio also increased from 6.9 in baseline phase to 11.5 in operation phase (Table 4.36).

Table 4.36 Social cost-benefit analysis of HCW incinerator project in Yala Province at baseline phase and after one-year operation

Items	Baseline	Operation
Costs per year (Baht)		
Labor	1,278,001	1,912,039
On-site management of healthcare facilities	1,047,971	669,424
Off-site management healthcare facilities	2,352,132	2,859,092
Operation and maintenance of central incinerator	-	1,276,007
Healthcare related cost of local population illness from emission of HCW combustion	29,388,427	18,098,318
Income loss of local population illness from emission of HCW combustion	4,942,427	3,517,796
Healthcare related cost of local population illness from HCW open dump	2,519,385	1,796,396
Income loss of local population illness from HCW open dump	608,903	385,380
Environmental damage from pollution emission	84,001	16,799
Net costs	**42,221,247**	**30,531,251**
Benefits per year (Baht)		
Saved healthcare related cost of local populations from using off-site incineration	286,823,521	333,389,524
Saved income loss of local populations from using off-site incineration	5,608,933	6,737,655
Saved healthcare related cost of local population illness after changing disposal methods from open burning/dump to central incineration	26,224	7,777,795
Saved income loss of local population illness after changing disposal methods from open burning/dump to central incineration	3,868	1,583,955
Save labor cost when changed to off-site incineration	106,200	138,800
Save environmental damage	249,640	326,775
Income from HCW transportation and incineration services	-	2,620,980
Net benefits	**292,818,386**	**352,575,484**
Benefit-cost ratio	**6.9**	**11.5**

4.4 Focus group discussion

After data collection and preliminary analysis, results were reviewed and its impact judgment was made by stakeholders both local and provincial levels. For local community level, indicators were divided into: population; facilities and services; safety and well-being concerns; community activities; and economy and resources. Population indicators covered growth rate, migration and temporally worker. For the group of facilities and services focused on transportation and road activities, safe water, healthcare, education, community waste management and religion activities. For safety and well-being concerns, the study focused on expectation, perception of risk and leaders' opinion toward the project. Three indicators used for community activities: grouping and activities, local norm and tradition, and communication and information accessibility. Economy and resource indicators covered land used pattern, land price, job opportunity, and recreation and aesthetics. There were two indicators set for provincial level: HCW management system and social cost benefit. Results of impact decision were presented in Table 4.37 and 4.38.

4.4.1 Populations

From secondary data and observation, stakeholders in focus group described that population growth rate was not impacted both construction and operation phase pattern of population growth rate in local area was similar to that of provincial level, and this project did not causes in-migration to the community. It was observed that in construction phase no people move in or move out the project setting area. However, in operation phase some villagers moved settle-down near the new road to the plant. The stakeholders agreed that this new area was safer from the political crisis than their former housing area and better in transportation. Temporally worker was not impact in both construction and operation phase because workers did not over-night in the plant during construction. For operation phase, all four workers were local people.

4.4.2 Facilities and services

Transportation and road activities of villagers were impacted by the project in both construction and operation phase. Although there was a new and better road to the plant, other roads were damage, noisy and dirty. These problems continued to operation phase. Safe water was slightly positive affected in construction phase and become better in operation phase. Villagers were afraid of infective organisms that might contaminate well water, so some villagers were changed source of drinking water from well water to commercial bottle water and tap water. The stakeholders described, although cost of drinking water might increased, but the commercial bottle water and tap water were safer than well water. They added that some wells were contaminated from landfill site near the local community. Healthcare, education and community waste management were not impact in both construction and operation phases. Religion activity was not impact in construction phase, but slightly negative affected in operation phase. Some stakeholders described that the village mosque located down wind of the project, smoke and bad smell sometime interfered them during in the mosque.

4.4.3 Safety and well-being concerns

The stakeholders concluded that the project induced both positive and negative impacts on villagers' expectation. For perception of risk, there was slightly negative impact on villagers' risk perception in construction phase because most villagers perceived moderated risk from the project. In operation phase, about half of villagers perceived high risk toward the project. However, data showed that leaders' opinion favored the project in construction phase, and more of them favored in operation phase. It was conclude that the project was positive impact on leaders' opinion.

4.4.4 Community activities

There was no group or activity affected by the project in construction phase. However, the project was slightly impact on community group and activity when some villagers employed to the project got higher status in operation phase. It was not found any change in indicators of local norm and tradition, and communication and information accessibility.

4.4.5 Economy and resources

The stakeholders decided that pattern of land used surround the project setting area was not change in construction phase, but positive changed in operation phase. It was positive impact because the land was safer living. However, price of land was not affected. The project slightly positive impacted on villagers' job opportunity in operation phase, since some local villagers employed to the project as waste workers. This group of workers could help other villagers finding job in the Yala municipality. For recreation and aesthetics, there was not impact because there was no recreation and aesthetics area in local community.

4.4.6 HCW management system

There was positive impact on provincial HCW management system. HCW segregation in private clinics was significantly improvement. Improvements of HCW disposal in healthcare facilities; covering hospitals, health centers and private clinic were also identified.

4.4.7 Social cost- benefit

The stakeholders decided that the project was benefit for the society since the project did not show any social burden and the costs of healthcare and environmental damage decreased after the project operation.

Table 4.37 Results of impact decision-making by focus group discussion

Local community level indicators	Impact decision	
	Construction	Operation
Populations		
-Growth rate	0	0
-Migration	0	+
-Temporally worker	0	0
Facilities and services		
-Transportation and road activities	--	--
-Safe water	+	++
-Healthcare	0	0
-Education	0	0
-Waste management	0	0
-Facility for religion activities	0	-
Safety and well-being concerns		
-Expectation	+-	+-
-Perception of risk	-	--
-Leaders' opinion	+	++
Community activities		
-Groups and activities	0	-
-Local norm and tradition	0	0
-Communication and information accessibility	0	0
Economy and resources		
-Land used pattern	0	+
-Land price	0	0
-Job opportunity	0	+
-Aesthetics	0	0

0 = not effect; + = positive effect

++ = very positive effect; - = negative effect

-- = very negative effect

Table 4.38 Impact judge of provincial level indicators

Provincial level indicators	**Impact decision**	
	Construction	**Operation**
- HCW management systems	NA	++
- Social cost-benefit	NA	++

NA = not applicable

++ = very positive effect

CHAPTER V
DISCUSSION

This chapter was divided into two parts: discussion of study results and proposal for Thai SIA guideline.

5.1 Discussion

Characteristics of local villagers surrounding the HCW incinerator project were similar to those of Yala provincial level populations [101]. More than half of respondents educated only primary school level or lower, and worked in rubber and fruit orchards. Only 10.7% of them received information about the project at baseline phase. Although a workshop about the HCW incinerator project conducted on December 19, 2005 by the Yala Municipality, proportion of local villagers who were informed about the project was low. At that time there were 48 participants in the workshop, however, most participants were health workers from various healthcare facilities in Yala province. Unfortunately, only two participants were representatives from two local communities. Since only two leaders participated in the workshop, resulted in ineffective communication with various groups of the communities. In local communities, there were many groups, for example, health volunteer, women leaders, mosque committee, and school committee, their representatives should participated in such workshop.

An evaluation of health impact at six months after operation was too short to detect any significant. The study found that proportion of villagers attending Satang-Nok health center and Yala hospital were similar at baseline phase. The proportions of villagers attending Satang-Nok health center significantly decreased from baseline phase (64.7%) to operation phase (32.3%, $p<0.001$), while in Yala hospital the proportion also slightly decreased. Cost of transportation was one factor affected on villagers' decision to go out or find healthcare service. This study found that cost of transportation in operation phase was two fold of baseline phase because gasoline price increased from 25 Baht in baseline phase to 40 Baht in operation phase. The average daily traffics were also decreased from 3,424 PCU per day at baseline phase to 3,142 PCU per day at operation phase (Table 4.11).

The project did not affect on villagers' opinions toward healthcare services. Opinion among the same respondents who attended the same healthcare services in baseline, construction and operation phases were not changed, except the opinion toward number of patients in Yala hospital which significantly decreased from baseline phase to operation phase. The improving caused by the improvement of the service from health center by mobile teams of nurses from Yala hospital to work at some health centers surrounding the Yala City. This policy was increased patients in health centers, but decreased patients in private clinics and Yala hospital [101].

The project affected selecting sources of drinking water in the local communities. Sources of drinking water significantly changed from baseline phase to construction phase and to operation phase ($p<0.001$). Proportion of villagers drinking well water, both from deep well and shallow well, decreased, while proportion of drinking commercial bottled water increased (Table 7). The data from focus group discussion showed that some villagers affected by the former landfill site nearby the community. Some wastewater from the landfill contaminated villager's well water and their rice field, and also caused skin diseases in children especially during rainy season. These negative experiences caused villagers' concern of well water contamination from the HCW incinerator project. Some villagers avoid drinking well water, and turned to commercial bottle water for better quality even cost more.

Road activities and transportation of local community were significantly impacted during the construction. Although numbers of vehicles decreased, number of trucks in construction phase were two fold of those in baseline phase. Heavy truck caused loud noise, dust and particle, and road surface broken. The villages also reported problems of dirty road, breaking road surface and loud noise during walking, riding motorcycle, and riding car along village road at construction phase (Table 4.9-4.16). It was showed that problem of dust was not significant because construction period was in rainy season; the rain could minimize dust dispersion. However, road dirty and road surface damage occurred. These problems were concerned and discussed in the focus group discussion of stakeholders, especially during transporting materials to the plant for construction. From the focus group discussion, a Yala municipality's representative presented their plan to improve road to the incinerator plant.

Villagers' religion activities were not impacted during construction and operation of the incinerator (Table 14), although the village mosque was down wind from the HCW incinerator. However, number of villagers attending the village's mosque decreased from baseline phase to construction and operation phases because a new mosque constructed in the village and began the service. Some villagers used the new mosque that closed to their houses instead of the old one.

The villagers who expected job from the project significantly increased from baseline phase (7.7%) to construction phase (14.0%) and to operation phase (26.0%) because they wanted a job near their home. Some villagers were laborers in the Yala city, about ten kilometers from the plant, and some of villagers were unemployment. Rate of unemployment in local community was 8.1% at baseline phase; this rate was quite high compared to those at the province level (0.8%) and national level (1.4%) at the same period. However, only one local villager employed during construction phase and four villagers employed as waste workers in operation phase.

Expectations toward community development, and clean environment were also significant ($P < 0.001$). Data from in-depth interview showed that community development and clean environment related to moving landfill site far away from populated community. Some villagers expected if the project could be settled, a landfill, about 500 meters from the community school, would be closed, and a new landfill would be constructed at the same area of the incinerator, about three kilometers from the school. This showed that villagers did not believe the incinerator would improve their environment but closing old landfill would.

Some negative expectations such as bad smell, infective organisms, and danger from car traffic increased significantly ($p < 0.01$). Similarly, data of health risk perception also showed that rates of villagers perceiving high risk increased significantly from baseline phase to operation phase ($p<0.001$, Table 4.14). The villagers increased their risk perception toward the HCW incinerator project if experienced some problems related to the project such as bad smell, smoke, loud noise and disturbances from vehicles (Table 4.14). Occurrence of socio-economic disadvantage among people lived near hazardous waste site was reported [111]. The long-term health impacts were also identified [112-113].

This study showed villagers concerned with emissions from incinerator. The expectation of most villagers from smoke of the HCW incinerator did not change in three phases. Data from in-depth interview also showed that smoke was the key factor for community leader to accept the project. Other studies also showed that emission from incinerator was in public concern [110, 112]. There were up to 60 chemicals from incinerator stake identified [113]. Various boundaries of stake emission were defined and recommended for safety of surrounding population [110-117]. Psychological impacts on residents living within two kilometers radius of incinerator were observed [110]. Increased risk of liver cancer was identified in those living within one kilometer of municipal incinerator [118]. Five kilometers radius was used for human risk assessment [119-120]. In Thailand, recommendation for incinerator site selection was two kilometers far from urban center [121].

For healthcare facilities, most staffs who took responsibility in waste management received formal training in waste management at both baseline phase (62.2%) and operation phase (63.0%). Training of waste handlers and healthcare personnel was important [88]. The risk waste should be handled properly to ensure waste workers and general populations did not expose infective organisms. Public education on HCW could be beneficial in preventing of HCW exposure, encouraging of risk awareness and promoting responsibility for proper management [88]. Although, regulation for HCW management in Thailand has decreed since 2002 [121-122], this study found that only hospitals and health centers properly segregated hazardous HCW in red bag (100.0%). Unfortunately, improper HCW disposal was worse. Similar problems on hazardous HCW regulation in other developing country were reported [46,123-124]. Availability of central HCW incineration in the region showed improvement of HCW management in all types of healthcare facilities. Similar information was reported in previous study [124]. Therefore, regulation alone may not effective if facility for HCW disposal is not available.

Rate of daily hazardous HCW generated from hospitals studied, health centers and private clinics were similar in baseline and operation phases. Change in methods and place of HCW managements in various healthcare facilities affected the cost of HCW management. Among the 11 hospitals, costs of waste worker, and waste transportation decreased from baseline to operation phase ($p < 0.05$). However, cost of waste bag and HCW disposal significantly increased from baseline phase to operation phase (0.05). Proportion of red bag usage increased in the hospital that changed method of HCW disposal from on-site incineration to off-site incineration. Some clinics where owners were hospital staffs brought hospital red bag to use in the clinics. Opinions toward proper handle of HCW segregation among staffs of clinics increased from 34.0% at baseline phase to 76.6% at operation phase ($p < 0.001$). The opinion toward high cost of HCW disposal also increased from baseline (17.0%) to operation phase (38.3%, $p = 0.032$, Table 4.27).

Cost related to HCW management in hospitals decreased about five million Baht after the Yala central HCW incinerator operated. Costs saving were from avoiding local villagers exposed to hospital incinerators emission. At baseline phase, some hospitals had to transport their HCW to Hat Yai central HCW incinerator that about 150 kilometers from Yala province because of local people complained about their hospital incinerator emission. The central incinerator project gained benefit for local hospitals as showed that the benefit cost ratio of HCW management in hospital improved from 21.7 in baseline phase to 36.9 in operation phase.

For health center, about two millions Baht saving in operation phase compared to baseline phase. These monetary saving occurred from saving health of local villagers from open burning and open dumping, because some health centers transferred their HCW to the hospital for incineration in the central HCW incinerator. Since proportion of health center disposed their HCW by the central HCW incinerator quite low, benefit-cost ratio of HCW management in health center slightly improved from 0.17 in baseline phase to 0.31 in operation phase, the ratio was less than expected [99].

Net cost of HCW management in clinics was about three million Baht reduced from baseline phase to operation phase. Most costs saving occurred from saving health of local people from infectious diseases via open dumping of HCW. Although most clinics disposed their HCW by transferring to local government for open dump, about 5% of dump waste was fired [111]. About 12 million Baht of environmental damage cost in baseline phase were saved in operation phase by using the central HCW incinerator instead of open dumping. The benefit cost ratio of HCW management in clinics improved from 0.11 in baseline phase to 1.21 in operation phase.

For cost-benefit of the central HCW incinerator management, two scenarios were compared, with and without investment cost. When excluded investment cost, about one million Baht was benefit after one-year operation. The benefit-cost ration was 1.53 that feasible for investment [99] because the Yala municipality loaned a 100% without interest funding. The analysis including investment cost found that the score of benefit cost ratio in the first year was 0.07, and 0.73 at the end of project.

Over all social cost-benefit analysis of HCW management in Yala province after one year, operation showed that net costs reduced from 52.1 millions Baht in baseline phase to 38.9 millions Baht in operation phase. Net benefits improved from 26.7 millions Baht in baseline phase to 46.4 million Baht in operation phase. The benefit cost ratio also improved in operation phase. The project showed benefits to both local populations and healthcare services.

5.2 Guideline for SIA methods in Thailand

The principle of SIA is to determine if the proposed action (activity, project, program and policy) make any impact on people’s way of life, both positive and negative. SIA also aims at manage the intended consequences to create more sustainable human environment. SIA can conduct voluntarily and compulsorily. If SIA is a part of EIA or other impact assessment, basic process of impact assessment should be followed: screening, scoping, appraisal, report, review and decision-making, monitoring and evaluation. SIA should involve stakeholders at the early stage of the process to create transparency and equity. Support from stakeholders may lead local people to accept the development project. Special groups of people, particularly, vulnerable groups, should be consulted. The following is the practical guideline in conducting SIA study in Thailand.

The basic design of SIA study is an evaluation research. In addition, SIA could compare information of two or more communities/areas with and/or without the proposed action, or between different alternatives of the proposed actions. A concurrent SIA could be applied by following cycle of the proposed action and the study may need two or three rounds of data collection: baseline, construction and operation phases. A projecting of SIA impact may be carried out if accurate impact data from similar proposed action in similar target population. However, different groups of population may have different attitudes and values on the proposed action and its impact. This design may need fully participation of community.

The final step of data gathering will be public forum to decide if the proposed action impact on people’s life in the area affected.

Variables suggested, Table 5.1, should be included in the SIA study. Other than the variables of development project concerned, for example, the nature of the project, expected outcome of the project, people affected by the project, particularly those who have to move out of their villages

Table 5.1 Suggested SIA variables and scope of the study

Variable	Scope
1. Population	
-Number	-Number of people affected
-Pattern	-Review population pattern, proportion of dependent group, etc.
-Growth rate	-Trend of growth rate
-Migration	-Rate of immigration and emigration
-Temporally worker	-Number and proportion of temporally worker, season and duration
2. Infrastructure	
-Transportation and road activities	-Route, average daily traffic, types of vehicle used and frequency, opinion toward road activity
-Safe water	-Sources of drinking water and water supply, coverage of safe water accessibility
-Healthcare	-Health facility, opinion toward healthcare service
-Education	-Number of school, level of provided education and capacity
-Community waste management	-Rate of generation, and disposal methods of solid waste, wastewater etc.
-Facility for religion activity	-Existing, attending religion activity, opinion toward religion activity
-Factors concern, other system related to the proposed action	-For example, additive air pollution from other factories

Table 5.1 Recommended SIA indicator and scope of the study (cont.)

indicators	Scope
3. Safety and well-being concerns	
-Expectation from the project	-Expectation both positive and negative ways
-Perception of risk	-Risk perception toward the project
-Leaders' opinion	-Opinion toward the project, opinion toward the project vender
4. Community activities	
-Groups and activities	-Community grouping, activity, committee and its function
-Local norm and tradition	-Important tradition, norm and value
-Communication and information accessibility	-Community relation and communication channel
5. Economics	
-Job opportunity	-Rate of employment, working skill, income and occupation
-Land used pattern	-Existing land used and zoning
-Land price	-Existing price of land and trend
-Production and consumption	- Important goods import and export from the local community
6. Resources	
-Aesthetics and sightseeing area	-Type and use of the area, and benefits of local people
-Preservative area	- Activity and benefit of local people related to the area
-Ancient and spiritual site	- Activity of local people, and benefit of local people related to the site

In addition, it is suggested, SIA investigator should pay attention to the local people's concern since people in different area have different problems and interest.

Data in SIA study will combine primary and secondary sources depending on the nature and availability of data in the area. For example, people's perception and expectation may be primary data while population pattern may be secondary information. Methods used for gathering will be a combination of quantitative and qualitative methods.

Analysis: based on the study design, the analysis has to compare between different groups of data, for example, baseline and construction, baseline and implementation, construction and implementation, alternative A and alternative B, community with and with out the proposed action.

The impact decision step as mentioned will be the public forum to decide if the proposed action has any impact people's way of life in the area, if so in which way. Mitigation measures should be carried out to prevent or minimize negative impact.

Finally, plan for monitoring and evaluation should be developed to follow up, especially, the significant impacts, and to ensure the mitigation measures being implemented.

CHAPTER VI
CONCLUSION

6.1 Conclusion

Characteristics of the local villagers at the study areas were not different from those of provincial level. A workshop organized was not effective in informing local villager about the HCW incinerator project. The project did not affect accessibility to the services of healthcare, education and water supply of local villagers. However, it significantly affected villagers' health risk perception, including activities of selecting drinking water. Road activities were also significantly affected, especially at construction phase. Problems of dirty road, damaged road and loud noise from the traffic were identified.

Water sources contamination and air pollution from the incinerator were serious concern of local villagers. Both community leaders and villagers were aware of toxic air pollutions. Some negative expectations, such as bad odor, infective organisms, and danger from car traffic also significantly increased. On the other hand, some positive expectation, such as job from the project, community development, and clean environment significantly increased.

Land used pattern surrounding the project and villager migration slightly changed after one year of project operation. Three new houses constructed along the new road to the project. However, land price at local village did not change. Community structure tended to change when group of waste workers employed by the project became new leaders because they had better income and could help others to find job in Yala municipality, which made them get higher status in the community.

The study showed improvement of HCW management in all healthcare service sectors, hospital, health center and clinic after one year of central HCW incinerator operation, while some healthcare services' respondents thought their cost of HCW management increased. However, a cost benefit analysis showed that the project gained benefit to both healthcare services and the project vender.

6.2 Recommendations

6.2.1 Recommendations for the HCW incinerator project

1. Local people perceived health risk from the incinerator stack emission, including well water contamination. Periodical check of stack emission and contaminate of well water should be done, and the results should be used to inform local communities.

2. This project impacted on villagers' road activities. Waste vehicle should avoid peak hour traffic to minimize impact on villagers' road activities. Road maintenance should be carried out because some damage occurred during construction phase.

3. Local villagers expected job and better income from the project. They should be prioritized for employment. However, qualification should be taken into account.

4. The central incinerator with emission control equipment should be promoted because it lead to a better management system of HCW. More over, cost benefit analysis showed advantage for the society.

5. Waste handlers should be trained in HCW management to prevent risk for themselves and the public and to improve HCW management system.

6. Location for incinerator setting should avoid populated area.

6.2.2 Recommendations for further study

SIA process used in this study could be used as guideline for SIA study in different development projects.

6.3 Strengths of the study

1. This study combined technical and participatory SIA methods together to improve SIA quality.

2. Methods used for data collection in this study covered both quantitative and qualitative methods to enhance strength and validity of data gathered.

3. This study designed a concurrent study that gathered data from the real situations systematically. Therefore, information in this study was reasonable to generate guideline and/or apply for other studies.

6.4 Limitation of the study

The third round of data collection was about one year after the project operated; it might be too short to detect the impact.

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APPENDICES

APPENDIX A

Questionnaire 1 **No. …………………**

SIA of central healthcare waste incinerator project in Satang Nok subdistrict, Muang District, Yala province

Date …………./…………./…………….

Part 1: General information

1) Head of household ( ) Yes ( ) No, if not, what are your relationship to the head of household

2) Sex ( ) Male ( ) female

3) Age………………….. years

4) Religion ( ) Islam ( ) Buddhism ( ) Other(specify) ……….

5) Educational attainment

( ) No formal education

( ) Primary level (Grade 1-6)

( ) Secondary or High school level (Grade 7-12)

( ) Vocational school level

( ) Graduated level or higher

( ) Religion study, grade……………………

6) Occupation (earning highest income)

( ) Village grocery ( ) Food shop in village

( ) Fruits and vegetable shop in village ( ) Owner of rubber orchard

( ) Laborer for rubber orchard ( ) Other laborer

( ) Goods selling in weekend market ( ) Non-income occupation

( ) Laborer for vegetable or fruit tree orchard

( ) Owner of vegetable or fruit tree orchard

( ) Other (specify) ………………………..

7) Do you know about healthcare waste incinerator project in Yala province?

( ) No

( ) Yes, from whom ……………………………………

8) Number of family member	……………	Male……..…	Female……….
Children under 1 years	……………	Male……..…	Female……….
Children between 1-5 years	……………	Male……..…	Female……….
9) Age 60 years or higher	……………	Male……..…	Female……….
Employed	……………	Male……..…	Female……….
10) Children between 15-60 years	……………	Male……..…	Female……….
Employed/study	……………	Male……..…	Female……….
11) Children 6-14 years	……………	Male……..…	Female……….
Not attend school	……………	Male……..…	Female……….

Part 2: Accessibility to community infrastructure and service

Healthcare

12) Have some of your family members received healthcare service from Satang Nork health center in this month?

( ) No (go to question no. 14)

( ) Yes

13) If yes, how is healthcare service in Satang Nork health center?

13.1 provider	( ) satisfied	( ) unsatisfied
13.2 number of patients	( ) many	( ) fair
13.3 waiting time	( ) long	( ) short
13.4 transportation	( ) convenience	( ) inconvenience

14. Have some of your family members received healthcare service from Yala hospital in this month?

( ) No (go to no. 16) ( ) Yes

15) If yes, how is healthcare service in Satang Nork health center?

15.1 provider	( ) satisfied	( ) unsatisfied
15.2 number of patients	( ) many	( ) fair
15.3 waiting time	( ) long	( ) short
15.4 transportation	( ) convenience	( ) inconvenience

Water supply

16) Which source of drinking water do you use most in this month?

( ) Bottle water(go to no.18) ( ) Rain water

( ) Well water ( ) Tap water

( ) Other (specify)………………………………………….

17) Do you treat water before drinking?

( ) No

( ) Yes, by ( ) Boiling

( ) Chlorination

( ) Filtration

( ) Other (specify)…………………………….

18) Which source of use water do you use most in this month?

( ) Tap water

( ) Well water

( ) Rain water

( ) Other (specify)…………………………………..

19) Do you treat use water before use?

( ) No

( ) Yes, by ( ) Boiling

( ) Chlorination

( ) Filtration

( ) Other (specify)…………………………….

Electricity

20) Do you have electricity in your house?

( ) Yes

( ) No(go to no. 23)

21) If yes, Are there any problem regarding insufficiency in this month?

( ) Nor

( ) Yes, occurred 1-2 times

( ) Yes, occurred more than 2 times

22) If yes, Are there any problem regarding electricity went out in this month?

( ) No

( ) Yes, 1-2 times

( ) Yes, more than 2 times

Transportation

23) How often do you walk along the village road this month?

( ) No (go to no. 25)

( ) 1-2 times

( ) 3-4 times

( ) Daily

( ) Other …………… times

24) What do you think about the following aspects?

24.1 Number of cars	( ) Many	( ) Fair
24.2 Dust	( ) Much	( ) Fair
24.3 Cleanness	( ) Clean	( ) Not clean
24.4 Road surface	( ) Broken	( ) Fair
24.5 Noise	( ) Loud	( ) Fair

25) How often do you ride bicycle along the village road this month?

( ) No (go to no. 27)

( ) 1-2 times

( ) 3-4 times

( ) Daily

( ) Other …………… times

26) What do you think about the following aspects?

24.1 Number of cars	( ) Many	( ) Fair
24.2 Dust	( ) Much	( ) Fair
24.3 Cleanness	( ) Clean	( ) Not clean
24.4 Road surface	( ) Broken	( ) Fair
24.5 Noise	( ) Loud	( ) Fair

27) How often do you ride motorcycle along the village road this month?

( ) No (go to no. 29)

( ) 1-2 times

( ) 3-4 times

( ) Daily

( ) Other …………… times

28) What do you think about the following aspects?

24.1 Number of cars	( ) Many	( ) Fair
24.2 Dust	( ) Much	( ) Fair
24.3 Cleanness	( ) Clean	( ) Not clean
24.4 Road surface	( ) Broken	( ) Fair
24.5 Noise	( ) Loud	( ) Fair

29) How often do you ride a car along the village road this month?

( ) No (go to no. 31)

( ) 1-2 times

( ) 3-4 times

( ) Daily

( ) Other …………… times

30) What do you think about the following aspects?

24.1 Number of cars	( ) Many	( ) Fair
24.2 Dust	( ) Much	( ) Fair
24.3 Cleanness	( ) Clean	( ) Not clean
24.4 Road surface	( ) Broken	( ) Fair
24.5 Noise	( ) Loud	( ) Fair

Religion activity

31) How often do you go to the village mosque this month?

( ) No (go to no. 33)

( ) Daily ( ) 4-5 times a week

( ) 2-3 times a week ( ) Every Friday

( ) Other (specify)…………………………………….

32) What do you think about the following aspects?

32.1 Number villagers	( ) Many	( ) Fair
32.2 Air ventilation	( ) Good	( ) Not good
32.3 Dust	( ) Much	( ) Fair
32.4 Smoke	( ) Much	( ) Fair
32.5 Drinking water	( ) Sufficient	( ) Insufficient
32.6 Use water	( ) Sufficient	( ) Insufficient

Part 3 Expectation from the HCW incinerator project

33) What are your positive expectation from the project?

( ) Job during construction period

( ) Job when plant operation

( ) Road to orchard/workplace

( ) Lighting at night time

( ) Better business

( ) Community development

( ) Source for waste disposal

( ) Clean environment

( ) Other (specify)…………………….

34) What are your negative expectation from the project?

( ) Bad smell

( ) Loss area for cattle raising

( ) Infective organism when waste be transported

( ) Bad people coming during construction

( ) Bad people coming when plant operation

( ) Danger from car traffic

( ) Smoke from incinerator

( ) Dust from the traffic

( ) Other (specify)………………………

Part 4 Perception

35. In this part, we would like to ask your opinion about waste incinerator in various aspects. There is no right or wrong in regarding the opinion, but we would like to have your actual opinion.

Items	Agree	Neutral	Disagree
35.1 Healthcare waste dose not harm people			
35.2 People annoy with healthcare waste odor			
35.3 Noise of waste vehicle does not bother villager			
35.4 Incinerator make people feel troble			
35.5 Smoke from incinerator irritate villager			
35.6 Smoke from incinerator does not harm villager			
35.7 Smoke from incinerator does not pollute well-water			
35.8 Vegetable grown near incinerator can be consumed			
35.9 Waste vehicle interrupts transportation in the village			
35.10 Waste vehicle does not make dirty road			
35.11 The Yala municipality can prevent villager from harm of incinerator			
35.12 Village has clean air			
35.13 People should move away from incinerator			
35.14 Incinerator destroys germs			

Part 5 Problem and recommendation

36. What are the problem(s) from waste incinerator project that you or your household member experienced?

………………………………………………………………………………………

………………………………………………………………………………………

37. What would you like the incinerator project do?

………………………………………………………………………………………

………………………………………………………………………………………

APPENDIX B

Questionnaire 2 **No…………………**

SIA of central healthcare waste incinerator project in Satang Nork subdistrict,
Mueang district, Yala province

Date…………./……………/……………..

Part 1 General information

1. Sex ( ) Male ( ) Female

2. Age………… years

3. Education

( ) Primary school (Grade 1-6)
( ) Secondary school or vocational certificate (Grade 7-12)
( ) Higher vocational certificate or public health certificate or related
( ) Bachelor degree
( ) Master degree or higher
( ) Other(specify)……………………………

4. Religion

( ) Islam ( ) Buddhist ( ) Other(specify)……..

5. Type of healthcare service

( ) Hospital ( ) Medical clinic
( ) Dental clinic ( ) Veterinarian clinic
( ) Medical laboratory
( ) Health center or PCU of the Ministry of Public Health
( ) Health center or PCU of municipality

6. Work position

( ) Medical doctor ( ) Veterinarian medical doctor
( ) Nurse ( ) Dentist
( ) Medical scientist ( ) Medical technologist
( ) Public health officer ( ) House keeper
( ) Others(specify)…………………….

7. Do you manage healthcare waste ?

( ) Yes

( ) No

8. Do you know how to manage healthcare waste?

( ) No

( ) Yes, if yes from…..

( ) Textbook or document

( ) Radio

( ) TV

( ) Training organized by………………

( ) Other…………………….

Part 2 Healthcare waste management of healthcare service

9. How do you manage healthcare waste here?

9.1 Use red bag for healthcare waste	( ) Yes	( ) No(go to no.9.4)
9.2 Red bag with cross-skull symbol	( ) Yes	( ) No
9.3 Red bag with biohazard symbol	( ) Yes	( ) No

9.4 How do you stor healthcare waste?

( ) In closed container

( ) Pile up or in opened container

( ) In healthcare waste storage room of (specify) …………………………

9.5 Method for healthcare waste disposal

( ) Opened burning

( ) Used incinerator of (specify)………….

( ) Transferred to local government

( ) Other(specify)………………………

10. Average healthcare waste generated here ………… kg/day

11. How much cost of healthcare waste management last year?

11.1 Laborer cost …………Baht/mo. or ………..Baht/yr. ( ) No
11.2 Bag cost …………Baht/mo. or ……….Baht/yr. ( ) No
11.3 Transportation …………Baht/mo. or ………..Baht/yr. ( ) No
11.4 Disposal …………Baht/mo. or ………..Baht/yr. ( ) No
11.5 Ash disposal …………Baht/mo. or ………..Baht/yr. ( ) No
11.6 Chemical, disinfectant …………Baht/mo. or ………..Baht/yr. ( ) No
11.7 Staff training ………..Baht/yr. ( ) No
11.8 Tool or equipment ………..Baht/yr. ( ) No
11.9 Waste container ………..Baht/yr. ( ) No
11.10 Waste cart ………..Baht/yr. ( ) No
11.11 Construction or improved waste storage ………..Baht/yr. ( ) No
11.12 Other(specify)………………….. ………..Baht/yr. ( ) No

12. How do you think about your waste management?

12.1 Separated healthcare waste from other waste ( ) Yes ( ) No
12.2 Pull or throw waste bag ( ) Yes ( ) No
12.3 Method of disposal ( ) Proper ( ) Improper
12.4 Cost of waste bag ( ) Fair ( ) Expensive
12.5 Cost of transportation ( ) Fair ( ) Expensive
12.6 Cost of disposal ( ) Fair ( ) Expensive

13. Other problem and recommendation……………………………………………
…………………………………………………………………………………..

APPENDIX C

In-depth interview guide

1. Opinion toward the incinerator project
2. Villager migration pattern and cause
3. Community grouping including advantage and disadvantage
4. Local tradition and practice
5. Impact expected on land and housing prices

APPENDIX D

Calculation of healthcare related cost of local people illness from HCW combustion

Items	**Scenario I**	**Scenario II**
(1) Target population	26,521	13,598
(2) Reference rate of respiratory disease (%)	36.05	36.56
(3) Relative risk from incinerator stack emission	1.78	1.78
(4) Rate of respiratory disease in study areas (%) = (2)x (3)	64.53	65.44
(5) Cases of respiratory disease (Reference) = [(1) x (2)]/100	9,558	4,971
(6) Cases of respiratory disease in areas with incinerator = [(1) x (4)]/100	17,109	8,899
(7) Cases of respiratory disease from incinerator stack emission = (6) – (5)	7,551	3,927
(8)Proportion of IPD case in Yala province (%)	15	15
(9) IPD cases = [(7) x (8)]/100	1,133	589
(10)OPD cases = (7) – (9)	6,418	3,338
(11)Unit cost for OPD case (Baht)	205	205
(12)Unit cost for IPD case (Baht)	5,638	5,638
(13)Healthcare cost for OPD cases (Baht) =(10)x(11)	1,315,751	684,339
(14)Healthcare cost for IPD cases (Baht) =(9)x(12)	6,385,828	3,321,350
(15)**Total healthcare cost** (Baht) =(13)+(14)	**7,701,579**	**4,005,689**
(16)Proportion of healthcare seeking behavior in Yala province (%)		
-(16.1)Within Sub-district or municipality	42	42
-(16.2)Out side Sub-district but within the District	48	48
-(16.3)Out side the District	10	10

APPENDIX D

Calculation of healthcare related cost of local people illness from HCW combustion (Cont.)

Items	**Scenario I**	**Scenario II**
(17)Healthcare seeking behavior (case)		
- (17.1)Within Sub-district or municipality = [(7)x42]/100	3,171	1,649
- (17.2)Out side Sub-district but within the District = [(7)x48]/100	3,624	1,885
- (17.3)Out side the District = [(7)x10]/100	755	189
(19) **Total travel cost for healthcare seeking** (Baht) = (18.1) + (18.2) + (18.3)	**188,169**	**81,286**
(20) **Healthcare related cost of local people illness from HCW combustion** = (15) + (19)	**7,720,448**	**4,086,975**

APPENDIX E

Calculation of healthcare related cost of local people illness from HCW open dump

Items	Scenario I	Scenario II
(1) Target population	15,011	10,228
(2) Reference rate of selected diseases (%)		
(2.1) Respiratory disease	36.05	36.56
(2.2) Skin infections	8.32	8.24
(2.3) Fever	0.50	0.91
(2.4) Eye infections	0.36	0.45
(2.5) Diarrhea	2.08	1.47
(3) Cases of selected diseases in target populations		
(3.1) Respiratory disease = (1) x(2.1)	5,412	3,739
(3.2) Skin infections = (1) x (2.2)	1,249	842
(3.3) Fever = (1) x (2.3)	75	93
(3.4) Eye infections = (1) x (2.4)	54	46
(3.5) Diarrhea = (1) x (2.5)	311	150
(4) Factor (proportion of un-sanitation born disease = 30%)	0.3	0.3
(5) Cases of selected diseases from open dump		
(5.1) Respiratory disease = (4) x(3.1)	1,624	1,122
(5.2) Skin infections = (4) x (3.2)	375	253
(5.3) Fever = (4) x (3.3)	23	28
(5.4) Eye infections = (4) x (3.4)	16	14
(5.5) Diarrhea = (4) x (3.5)	93	45
(5.6) Total	**2,131**	**1,461**
(6)Proportion of IPD case in Yala province (%)	15	15
(7) IPD cases = [(5.6) x (8)]/100	320	219
(8)OPD cases = (5.6) – (7)	1,811	1,242
(9)Unit cost for OPD case (Baht)	205	205
(10)Unit cost for IPD case (Baht)	5,638	5,638

APPENDIX E

Calculation of healthcare related cost of local people illness from HCW open dump (Cont.)

Items	Scenario I	Scenario II
(11)Healthcare cost for OPD cases (Baht) =(8)x(9)	371,216	254,598
(12)Healthcare cost for IPD cases (Baht) =(7)x(10)	1,801,797	1,235,660
(13)**Total healthcare cost** (Baht) =(11)+(12)	**2,173,043**	**1,490,258**
(14)Proportion of healthcare seeking behavior in Yala province (%)		
-(14.1)Within Sub-district or municipality	42	42
-(14.2)Out side Sub-district but within the District	48	48
-(14.3)Out side the District	10	10
(15)Healthcare seeking behavior (case)		
- (15.1)Within Sub-district or municipality = [(5.6)x42]/100	895	614
- (57.2)Out side Sub-district but within the District = [(5.6)x48]/100	1,023	701
- (15.3)Out side the District = [(5.6)x10]/100	213	146
(16)Travel cost of healthcare seeking (Baht)		
- (16.1)Within Sub-district or municipality = (15.1) x 40	35,793	24,547
- (16.2)Out side Sub-district but within the District = (15.2) x 80	81,813	56,107
- (16.3)Out side the District = (15.3) x 120	25,566	17,533
(17) **Total travel cost for healthcare seeking** (Baht) = (16.1) + (16.2) + (16.3)	**143,172**	**98,187**
(18) **Healthcare related cost of local people illness from HCW combustion** = (13) + (16)	**2,316,216**	**1,588,445**

APPENDIX F

Calculation of income loss of local people illness

Items	Scenario I	Scenario II
(1) Cases of selected disease from combustion or open dump	7,551	3,927
(Appendix IV, item (7) or Appendix V, item (5.6))		
(2) Proportion of dependence (%)	36	36
(3) Cases of dependence = [(1) x (2)]/100	2718	1414
(4) Proportion of IPD case in Yala province (%)	15	15
(5) Dependent IPD cases = [(3) x (4)]/100	407	212
(6) Dependent OPD cases = (3) – (5)	2311	1202
(7) Day of sick leave dependent OPD case	1	1
(8) Day of sick leave dependent IPD case	2.6	2.6
(9) General labor cost (Baht/day)	146	146
(10) Income loss from caring others, OPD case (Baht)	337,455	175,451
= (6) x (7) x (9)		
(11) Income loss from caring others, IPD case (Baht)	154,497	80,475
= (5) x (8) x (9)		
(12) **Income loss from caring others** (Baht) = (10) + (11)	**491,952**	**255,926**
(13) Cases of independence = (1) – (3)	4,833	2,513
(14) Independent IPD cases = [(4) x (13)]/100	724	377
(15) Independent OPD cases = (13) – (14)	4,109	2,436
(16) Income loss from sick leave independent OPD cases	599,856	311,897
= (7) x (9) x(15)		
(17) Income loss from sick leave independent IPD cases	274,830	413,109
= (8) x (9) x (14)		
(18) **Income loss from sick leave** = (16) +(17)	**874,686**	**455,006**
(19) **Income loss of local people illness** = (12) + (18	**1,366,628**	**701,932**

APPENDIX G

Calculation of CO_2- equivalent generated by on-site incinerator

Selected pollutants (1)	Emission factors (g/kg) (2)	HCW volume (kg/year) (3)	Emission volume (kg/year) (4)	Global warming Potential (5)	CO_2-equivalent (kg) (6)
CO_2	415.0	22,875	1,029.38	1	1,029.38
CO	1.48	22,875	33.86	3	101.57
NO	1.78	22,875	40.72	8	325.74
CH_4	0	22,875	0	21	0
NMVOC	0.15	22,875	3.43	11	37.74
PM	2.33	22,875	53.30	680	36,243.15
			Total		**37,737.37**

(4) = [(2) x (3)]/1000

(6) = (4) x (5)

APPENDIX H

Calculation of CO_2- equivalent generated by central incinerator

Selected pollutants (1)	Emission factors (g/kg) (2)	HCW volume (kg/year) (3)	Emission volume (kg/year) (4)	Global warming Potential (5)	CO_2-equivalent (kg) (6)
CO_2	4.5	75,628	340.33	1	340.33
CO	0.025	75,628	1.89	3	5.67
NO	0.038	75,628	2.87	8	890.90
CH_4	0	75,628	0	21	0
NMVOC	0.025	75,628	1.89	11	20.80
PM	0.038	75,628	2.87	680	1,954.23
			Total		**3,211.92**

(4) = [(2) x (3)]/1000

(6) = (4) x (5)

APPENDIX I

Calculation of CO_2- equivalent generated by open burning and dump-fired

Selected emission (1)	**emission factor (g/kg)** (2)	**waste volume (kg/year)** (3)	**emission volume (kg/year)** (4)	**GWP** (5)	**CO2-eqivalent (kg)** (6)
CO2	45	9,569.25	430.62	1	430.62
CO	42	9,569.25	401.91	3	1,205.73
NO	3	9,569.25	28.71	8	229.66
CH_4	6.5	9,569.25	62.20	21	1,306.20
NMVOC	15	9,569.25	143.54	11	1,578.93
PM	8	9,569.25	76.55	680	52,056.72
			Total		**56,807.85**

(4) = [(2) x (3)]/1000

(6) = (4) x (5)

APPENDIX J

Participant information sheet

(For population nearby waste incinerator plant)

This study is a Ph.D. thesis of Mr. Patthanasak Khammaneechan, a student of the Faculty of Tropical Medicine, Mahidol University. The study title is "Social Impact Assessment of Central Healthcare Waste Incinerator Project in Yala Province". The study aims to assess social impact of central healthcare waste incinerator project in Yala province. You are invited to enroll in this study because you are living near the project plant. In this study, there are about 250 heads of family or representatives in this area to be interviewed.

There are three times of interviews in this study. The first interview will be done immediately after you decide to enroll the study and sign the consent form. The second interview will be done in July 2007 and the third in March 2008. The interview will be taken about 30 minutes at your home. You will be asked about your opinion toward the central healthcare waste incinerator project and related information.

You are voluntarily participating this study. There will not have any direct benefit for participant, but it is a chance for you to share your opinion about the project. Your opinion are useful in developing mitigation guideline for further incinerator project. You are free in making decision if you will participate in this study. Whether you will participate this study or not, it will not be impacted to your living. You have your right not to answer some questions you do not prefer and withdraw any time you want. All information receiving from you will be kept confidential. It will be disclosed only in form of report.

You can contact Mr. Patthanasak Khammaneechan at telephone number 087-2907343 if you have any question. If you are not be treated as indicated in this document, you can inform the Ethical Committee of the Faculty of Tropical Medicine, Mahidol University, Research and Academic Affairs Unit, 2nd Floor, Chamlong Harinasuta Building, Faculty of Tropical Medicine, Mahidol University, Phone: 02-3549100 ext. 1524, 1525.

Informed consent form

(For population nearby waste incinerator plant)

I am …………………………………………….

I would like to participate in a study of social impact assessment of healthcare waste incinerator project in Yala province. I was informed about the study and asked questions until I was satisfied. Therefore, I voluntary participate in this study.

I can contact Mr. Patthanasak Khammaneechan at phone: 087-2907343 if I have any problems. If I do not be treated as indicated in this document, I can contact the Ethical Committee of the Faculty of Tropical Medicine, Mahidol University, Research and Academic Affairs Unit, 2nd Floor, Chamlong Harinasuta Building, Faculty of Tropical Medicine, Mahidol University, Phone: 02-3549100 ext. 1524, 1525.

I have the right to withdraw from this study at any time I want. I understand all information in participant information sheet and informed consent form. Then, I signed my name or print my thumb on the informed consent form as follow.

Signature	………………………………………	Participant
	………../…………./………………….	Date
Signature	……………………………………….	Head of research project
	………../…………./………………….	Date

In condition of the participant is illegible, the information was read by …………………

Signature	………………………………………	Witness
	………../…………./………………….	Date

Participant information sheet

(For healthcare service)

This study is a Ph.D. thesis of Mr. Patthanasak Khammaneechan, a student of the Faculty of Tropical Medicine, Mahidol University. The study title is “Social Impact Assessment of Central Healthcare Waste Incinerator Project in Yala Province”. This study aims to assess social impact of central healthcare waste incinerator project in Yala province. You are invited to enroll in this study because this health service is a service target of the waste incinerator project. In this study, there are about 90 health services in Yala province to be interviewed.

There are two tomes interviews in this study. The first interview will be done immediately after you decide to enroll the study and sign the consent form. The second interview will be done in March 2008. The interview will be taken about 30 minutes at your workplace. You will be asked about your opinion toward the central healthcare waste incinerator project and related information.

You are voluntarily participating this study. There will not have any direct benefit for participant, but it is a chance for you to share your opinion about the project. Your opinion are useful in developing mitigation guideline for further incinerator project. You are free in making decision if you will participate in this study. Whether you will participate this study or not, it will not impact to your work. You have right not to answer some questions you do not prefer and withdraw any time you want. All information receiving from you will be kept confidential. It will be disclosed only in form of report.

You can contact Mr. Patthanasak Khammaneechan at telephone number 087-2907343 if you have any question. If you are not be treated as indicated document, you can inform the Ethical Committee of the Faculty of Tropical Medicine, Mahidol University, Research and Academic Affairs Unit, 2nd Floor, Chamlong Harinasuta Building, Faculty of Tropical Medicine, Mahidol University, Phone: 02-3549100 ext. 1524, 1525.

Informed consent form

(For healthcare service)

I am …………………………………………….

I would like to participate a study of social impact assessment of healthcare waste incinerator project in Yala province. I was informed about the study and asked questions until I was satisfied. Therefore, I voluntary participate in this study.

I can contact Mr. Patthanasak Khammaneechan at phone: 087-2907343 if I have any problems. If I do not be treated as indicated in this document, I can contact the Ethical Committee of the Faculty of Tropical Medicine, Mahidol University, Research and Academic Affairs Unit, 2nd Floor, Chamlong Harinasuta Building, Faculty of Tropical Medicine, Mahidol University, Phone: 02-3549100 ext. 1524, 1525.

I have the right to withdraw from this study at any time I want. I understand all information in participant information sheet and informed consent form. Then, I signed my name or print my thumb on the informed consent form as follow.

Signature	………………………………………	Participant
	………../…………./………………….	Date
Signature	……………………………………….	Head of research project
	………../…………./………………….	Date

In condition of the participant is illegible, the information was read by …………………

Signature	………………………………………	Witness
	………../…………./………………….	Date

APPENDIX K

Comparison of villagers' accessibility to healthcare services between baseline, construction and operation phases

Items	Baseline N=300		Construction N=300		Operation N=300		P^{χ}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Visit Satang-Nok health center									
Yes	140	(46.7)	121	(40.3)	97	(32.3)	0.318	<0.001	0.051
No	160	(53.3)	179	(59.7)	203	(67.7)			
Visit Yala hospital									
Yes	146	(48.7)	146	(48.7)	135	(45.0)	>0.999	0.413	0.413
No	154	(51.3)	154	(51.3)	165	(55.0)			

$^{\chi}$ = Chi-square test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX L

Comparison of villagers' opinion toward healthcare services between baseline, construction and operation phases

Items	Baseline		Construction		Operation		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Satisfaction with provider in Satang-Nok health center (N=28)									
Yes	25	(89.3)	27	(96.4)	25	(89.3)	0.625	>0.999	0.500
No	3	(10.7)	1	(3.6)	3	(10.7)			
Number of patient in Satang-Nok health center (N=28)									
Many	2	(7.1)	4	(14.3)	1	(3.6)	0.625	>0.999	0.375
Fair	26	(92.9)	24	(85.7)	27	(96.4)			
Waiting time in Satang-Nok health center (N=28)									
Long	6	(21.4)	3	(10.7)	3	(10.7)	0.375	0.375	>0.999
Short	2	(78.6)	25	(89.3)	25	(89.3)			
Transportation to Satang-Nok health center (N=28)				(89.3)					
Convenience	27	(96.4)	25	(10.7)	22	(78.6)	0.625	0.250	0.125
Not convenience	1	(3.6)	3		6	(21.4)			
Satisfaction with provider in Yala hospital (N=41)									
Yes	30	(73.2)	36	(87.8)	33	(80.5)	0.180	0.508	0.549
No	11	(26.8)	5	(12.2)	8	(19.5)			
Number of patient in Yala hospital (N=41)									
Many	40	(97.6)	40	(97.6)	32	(78.0)	>0.999	0.008	0.008
Fair	1	(2.4)	1	(2.4)	9	(22.0)			
Waiting time in Yala hospital (N=41)									
Long	31	(75.6)	35	(85.4)	31	(75.6)	0.344	>0.999	0.344
Short	10	(24.4)	6	(14.6)	10	(24.4)			
Transportation to Yala hospital (N=41)									
Convenience	32	(78.0)	27	(65.9)	24	(58.5)	0.332	0.077	0.607
Not convenience	9	(22.0)	14	(34.1)	17	(41.5)			

^{Mc} = McNemar test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX M

Comparison of villagers' accessibility to water between baseline, construction and operation phases

Items	Baseline N=300		Construction N=300		Operation N=300		P^{χ}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Sources of drinking water									
Tap water	178	(59.3)	214	(71.3)	209	(69.7)	<0.001	<0.001	0.012
Deep well water	42	(14.0)	33	(11.0)	15	(5.0)			
Shallow well water	40	(13.3)	20	(6.7)	28	(9.3)			
Commercial bottle water	10	(13.3)	32	(10.7)	48	(16.0)			
Rainy water	0	(0.0)	1	(0.3)	0	(0.0)			
Sources of water supply									
Tap water	202	(67.3)	229	(76.3)	227	(75.7)	0.031	0.061	0.951
Deep well water	62	(20.7)	50	(16.7)	50	(16.7)			
Shallow well water	34	(11.3)	21	(7.0)	23	(7.7)			
Rainy water	2	(0.7)	0	(0.0)	0	(0.0)			

$^{\chi}$ = Chi-square test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX N

Comparison of villagers' road activities between baseline, construction and operation phases

Items	Baseline n	(%)	Construction n	(%)	Operation n	(%)	P^{Mc} BC	BO	CO
Frequency of walking along village road in a month									
Never	9	(19.6)	81	(27.0)	88	(29.3)	0.322	0.026	0.416
1-2 times	71	(23.6)	61	(20.3)	57	(19.0)			
3-4 times	33	(11.1)	30	(10.0)	41	(13.7)			
>5 times but not daily	5	(1.7)	5	(1.7)	2	(0.7)			
Daily	132	(44.0)	123	(41.0)	112	(37.3)			
Frequency of cycling along village road in a month									
Never	147	(49.0)	167	(55.7)	185	(61.7)	0.137	0.016	0.035
1-2 times	61	(20.3)	47	(15.7)	39	(13.0)			
3-4 times	27	(9.0)	16	(5.3)	29	(9.7)			
>5 times but not daily	1	(0.3)	3	(1.0)	1	(0.3)			
Daily	64	(21.4)	67	(22.3)	46	(15.3)			
Frequency of using motorcycle along village road in a month									
Never	46	(15.3)	36	(12.0)	40	(13.3)	0.340	0.175	0.126
1-2 times	52	(17.4)	42	(14.0)	45	(15.0)			
3-4 times	20	(6.7)	20	(6.7)	37	(12.3)			
> 5 times but not daily	7	(2.3)	4	(1.3)	5	(1.7)			
Daily	175	(58.3)	198	(66.0)	173	(57.7)			
Frequency of using car along village road in a month									
Never	128	(42.7)	130	(43.3)	158	(52.7)	0.609	0.025	0.051
1-2 times	79	(26.3)	73	(24.3)	75	(25.0)			
3-4 times	31	(10.3)	35	(11.8)	30	(10.0)			
> 5 times but not daily	10	(3.3)	16	(5.3)	10	(3.3)			
Daily	52	(17.4)	46	(15.3)	27	(9.0)			

$^{\chi}$ = Chi-square test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX O

Comparison of villagers' opinion related to road activities between baseline, construction and operation phases

Items	Baseline		Construction		Operation		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Number of vehicle during walking (N=150)									
Many	58	38.6	62	41.3	35	23.3	0.019	<0.001	<0.001
Fair	92	61.4	88	58.7	115	76.7			
Dust during walking (N=150)									
Much	91	60.7	97	64.7	95	63.3	0.003	0.004	<0.001
Fair	59	39.3	53	35.3	55	36.7			
Road cleanness during walking (N=150)									
Clean	54	36.0	36	24.0	60	40.0	<0.001	0.005	<0.001
Not clean	96	64.0	114	76.0	90	60.0			
Road surface during walking (N=150)									
Broken	81	54.0	105	70.0	113	75.3	0.008	0.001	<0.001
Fair	69	46.0	45	30.0	37	24.7			
Noise during walking (N=150)									
Loud	65	43.3	96	64.0	34	22.7	0.457	<0.001	0.042
Fair	85	56.7	54	36.0	116	77.3			

APPENDIX O

Comparison of villagers' opinion related to road activities between baseline, construction and operation phases (cont.)

Items	Baseline		Construction		Operation		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Number of vehicle during cycling (N=30)									
Many	11	36.7	13	43.3	9	30.0	0.376	0.089	0.169
Fair	19	63.3	17	56.7	21	70.0			
Dust during cycling (N=30)									
Much	19	63.3	16	53.3	16	53.3	0.441	0.441	0.855
Fair	11	36.7	14	46.7	14	46.7			
Road cleanness during cycling (N=30)									
Clean	12	40.0	13	43.3	14	53.3	0.472	0.596	0.719
Not clean	18	60.0	17	56.7	16	46.7			
Road surface during cycling (N=30)									
Broken	19	63.3	19	63.3	20	66.7	0.201	0.151	0.151
Fair	11	36.7	11	36.7	10	33.3			
Noise during cycling (N=30)									
Loud	17	56.7	13	43.3	10	33.3	0.845	0.677	0.248
Fair	13	43.3	17	56.7	20	66.7			

APPENDIX O

Comparison of villagers' opinion related to road activities between baseline, construction and operation phases (cont.)

Items	Baseline		Construction		Operation		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Number of vehicle during using motorcycle (N=214)									
Many	76	35.5	82	38.3	59	27.6	<0.001	<0.001	<0.001
Fair	138	64.5	132	61.7	155	72.4			
Dust during using motorcycle (N=214)									
Much	123	57.5	136	63.6	137	64.0	0.003	0.003	<0.001
Fair	91	42.5	78	36.4	77	36.0			
Road cleanness during using motorcycle (N=214)									
Clean	78	36.4	48	22.4	82	38.3	<0.001	<0.001	<0.001
Not clean	136	63.6	166	77.6	132	61.7			
Road surface during using motorcycle (N=214)									
Broken	135	63.1	150	70.1	173	80.8	<0.001	<0.001	<0.001
Fair	79	36.9	64	29.9	41	19.2			
Noise during using motorcycle (N=214)									
Loud	94	43.9	119	55.6	61	28.5	>0.999	<0.001	0.008
Fair	120	56.1	95	44.4	153	71.5			

APPENDIX O

Comparison of villagers' opinion related to road activities between baseline, construction and operation phases (cont.)

Items	Baseline		Construction		Operation		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Number of vehicle during using automobile (N=77)									
Many	27	35.1	28	36.4	20	26.0	0.017	<0.005	<0.001
Fair	50	64.9	49	63.6	57	74.0			
Dust during using automobile (N=77)									
Much	41	53.2	55	71.4	48	62.3	0.059	0.230	0.003
Fair	36	46.8	22	28.6	29	37.3			
Road cleanness during using automobile (N=77)									
Clean	37	48.1	15	19.5	25	32.5	0.001	0.082	0.003
Not clean	40	51.9	62	80.5	52	67.5			
Road surface during using automobile (N=77)									
Broken	43	55.8	66	85.7	60	77.9	0.002	0.009	<0.001
Fair	34	44.2	11	14.3	17	22.1			
Noise during using automobile (N=77)									
Loud	35	45.5	48	62.3	19	24.7	0.598	0.005	0.193
Fair	42	54.5	29	37.7	58	75.3			

^{Mc} = McNemar test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX P

Road activities survey in Ban Prama main road to the healthcare waste incinerator project in baseline, construction and operation phases

Types of vehicle	Baseline N=1,224		Construction N=1,362		Operation N=1,166		P^{χ}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Bicycle	103	8.4	58	4.3	66	5.7	<0.001	<0.001	<0.001
Motorcycle	550	44.9	470	34.5	644	55.2			
Pick-up	373	30.4	464	34.1	264	22.7			
Car/Van	102	8.3	176	12.9	72	6.2			
Truck	81	6.6	172	12.6	102	8.7			
Public service vehicle	15	1.2	22	1.6	18	1.5			

$^{\chi}$ = Chi-square test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX Q

Villagers' religion activities in baseline, construction and operation phases

Items	Baseline N=300		Construction N=300		Operation N=300		P^{χ}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Frequency of going to village mosque									
Never	72	(24.0)	88	(29.3)	92	(30.7)	0.190	0.082	0.979
1-4 times a month	62	(20.7)	47	(15.7)	44	(14.7)			
2-6 days a week	73	(24.3)	82	(27.3)	82	(27.3)			
Daily	93	31.0)	83	(27.7)	82	(27.3)			

$^{\chi}$ = Chi-square test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX R

Comparison of villagers' opinion related to religion activities between baseline, construction and operation phases

Items	Baseline N=153		Construction N=153		Operation N=153		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Number of villagers in the mosque									
Many	74	48.4	40	26.1	49	32.0	<0.001	0.010	<0.001
Fair	79	51.6	113	73.9	104	68.0			
Air ventilation in the mosque									
Good	142	92.8	131	85.6	142	92.8	<0.001	<0.001	<0.001
Not good	11	7.2	22	14.4	11	7.2			
Dust in the mosque									
Much	45	29.4	54	35.3	34	22.2	<0.001	<0.001	<0.001
Fair	108	70.6	99	64.7	119	77.8			
Smoke in the mosque									
Much	25	16.3	20	13.1	40	26.1	<0.001	<0.001	<0.001
Fair	128	83.7	133	86.9	113	73.9			
Drinking water in the mosque									
Sufficient	128	83.7	143	93.5	126	82.4	<0.001	<0.001	<0.001
Insufficient	25	16.3	10	6.5	27	17.6			
Water supply in the mosque									
Sufficient	118	77.1	127	83.0	135	88.2	<0.001	<0.001	<0.001
Insufficient	35	22.9	26	17.0	18	11.8			

^{Mc} = McNemar test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX S

Villagers' expectation from the healthcare waste incinerator project in baseline, construction and operation phases

Items	Baseline N=300		Construction N=300		Operation N=300		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Job from the project									
Yes	23	(7.7)	42	(14.0)	78	(26.0)	0.109	<0.001	<0.001
No	227	(92.3)	258	(86.0)	222)	(74.0			
Road to orchard/workplace									
Yes	81	(27.0)	84	(28.0)	111	(37.0)	0.854	0.011	0.023
No	219	(73.0)	216	(72.0)	189	(63.0)			
Lighting in night time									
Yes	87	(29.0)	86	(28.7)	110	(36.7)	>0.999	0.056	0.045
No	213	(71.0)	214	(71.3)	190	(63.3)			
Improvement of community economic									
Yes	60	(20.0)	71	(23.7)	76	(25.3)	0.222	0.143	0.704
No	240	(80.0)	229	(76.3)	224	(74.7)			
Community development									
Yes	130	(43.3)	172	(57.3)	188	(62.7)	<0.001	<0.001	0.211
No	170	(56.7)	128	(42.7)	112	(37.3)			
Facility for waste disposal									
Yes	200	(66.7)	230	(76.7)	219	(73.0)	0.008	0.109	0.346
No	100	(33.3)	70	(23.3)	81	(27.0)			
Clean environment									
Yes	179	(59.7)	230	(76.7)	211	(70.3)	<0.001	0.008	0.096
No	121	(40.3)	70	(23.3)	89	(29.7)			
Nuisance from bad odor									
Yes	215	(71.7)	252	(84.0)	236	(78.7)	<0.001	0.059	0.116
No	85	(28.3)	48	(16.0)	64	(21.3)			
Loss area for cattle raising									
Yes	30	(10.0)	23	(7.7)	31	(10.3)	0.388	>0.999	0.381
No	270	(90.0)	277	(92.3)	269	(89.7)			

APPENDIX S

Villagers' expectation from the healthcare waste incinerator project in baseline, construction and operation phases (cont.)

Items	Baseline N=300		Construction N=300		Operation N=300		P^{Mc}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Infective organism when waste be transported									
Yes	49	(16.3)	185	(61.7)	210	(70.0)	<0.001	<0.001	0.038
No	251	(83.7)	115	(38.3)	90	(30.0)			
Bad people coming during construction									
Yes	49	(16.3)	64	(21.3)	74	(24.7)	0.143	0.013	0.036
No	251	(83.7)	236	(78.7)	226	(75.3)			
Danger from car traffic									
Yes	128	(42.7)	155	(51.7)	176	(58.7)	0.033	<0.001	0.101
No	72	(57.3)	145	(48.3)	124)	(41.3			
Smoke from incinerator									
Yes	237	(79.0)	245	(81.7)	242	(80.7)	0.473	0.684	0.834
No	63	(21.0)	55	(18.3)	58	(19.3)			
Dust from the traffic									
Yes	161	(53.7)	172	(57.3)	194	(64.7)	0.411	0.008	0.079
No	139	(46.3)	128	(42.7)	106	(35.3)			
Danger from materials and equipments									
Yes	10	(3.3)	2	(0.7)	6	(2.0)	0.041	0.447	0.285
No	290	(96.7)	298	(99.3)	294	(98.0)			

^{Mc} = McNemar test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

APPENDIX T

Villagers' risk perception toward healthcare waste incinerator project in baseline, construction and operation phases

Items	Baseline N=300		Construction N=300		Operation N=300		P^{χ}		
	n	(%)	n	(%)	n	(%)	BC	BO	CO
Low	9	(3.0)	4	(1.3)	6	(2.0)	0.185	<0.001	<0.001
Moderate	181	(60.3)	198	(66.0)	136	(45.3)			
High	110	(36.7)	98	(32.7)	158	(52.7)			

$^{\chi}$ = Chi-square test
BC = Comparison between baseline and construction phases
BO = Comparison between baseline and operation phases
CO = Comparison between construction and operation phases

BIOGRAPHY

NAME	Mr.Patthanasak Khammaneechan
DATE OF BIRTH	22 October 1966
INSTITUTIONS ATTENDED	Mahidol University, 1989
	Bachelor of Science
	(Public Health)
	Mahidol University, 1997
	Master of Science
	(Tropical Medicine)
	Mahidol University, 2009
	Doctor of Philosophy
	(Tropical Medicine)
HOME ADRESS	78 Petchakasem Rd., Khok Pho,
	Pattani, 94120
	Tel. 087-2907343
	E-mail kpathanasak@hotmail.com
EMPLOYMENT ADRESS	The regional health promoting center 12th
	95 Tessaban 1 Rd., Muang, Yala,
	95000
	E-mail patthanasak.k@anamai.mail.go.th