DEVELOPING HEALTH IMPACT ASSESSMENT TOOLS:
A CASE STUDY OF CEMENT FACTORY IN NAKHON SI THAMMARAT PROVINCE, THAILAND

Mr. Phayong Thepaksorn

A Dissertation Submitted in Partial Fulfillment of the Requirements

for the Degree of Doctoral of Public Health Program in Public Health

College of Public Health Sciences

Chulalongkorn University

Academic Year 2012

การพัฒนาเครื่องมือประเมินผลกระทบต่อสุขภาพ

กรณีศึกษาโรงงานผลิตภัณฑ์ซีเมนต์ จังหวัดนครศรีธรรมราช ประเทศไทย

นายพยงค์ เทพอักษร

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต

สาขาวิชาสาธารณสุขศาสตร์

วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย

ปีการศึกษา 2555

Thesis Title	DEVELOPING HEALTH IMPACT ASSESSMENT TOOLS: A CASE STUDY OF CEMENT FACTORY IN NAKHON SI THAMMARAT PROVINCE, THAILAND
By	Mr.Phayong Thepaksorn
Field of Study	Public Health
Thesis Advisor	Associate Professor Sathirakorn Pongpanich, Ph.D.

Accepted by the College of Public Health Sciences, Chulalongkorn University in Partial Fulfillment of the Requirements for the Doctoral Degree

……………………………………..Dean of the College of Public Health Sciences
(Professor Surasak Taneepanichskul, M.D., M.Med.)

THESIS COMMITTEE

……..………………………………Chairman
(Professor Surasak Taneepanichskul, M.D., M.Med.)

…………………………………….. Thesis Advisor
(Associate Professor Sathirakorn Pongpanich, Ph.D.)

……………………………………..Examiner
(Assistant Professor Wattasit Siriwong, Ph.D.)

…………………………………….. Examiner
(Robert Sedgwick Chapman, M.D., M.P.H.)

…………………………………….. Examiner
(Theechat Boonyakarnkul, M.Sc.)

พยงค์ เทพอักษร: การพัฒนาเครื่องมือประเมินผลกระทบต่อสุขภาพ กรณีศึกษาโรงงานผลิตภัณฑ์ซีเมนต์ จังหวัดนครศรีธรรมราช ประเทศไทย. (DEVELOPING HEALTH IMPACT ASSESSMENT TOOLS: A CASE STUDY OF CEMENT FACTORY IN NAKHON SI THAMMARAT PROVINCE, THAILAND) อ.ที่ปรึกษาวิทยานิพนธ์หลัก รศ.ดร.สถิรกร พงศ์พานิช, 189 หน้า.

วัตถุประสงค์หลักของการศึกษาวิจัยนี้คือเพื่อพัฒนาเครื่องมือในการประเมินความเสี่ยงทางสุขภาพสำหรับอุตสาหกรรมผลิตกระเบื้องซีเมนต์ การศึกษานี้แบ่งเป็น ๒ ระยะ(Phase) ระยะที่ ๑ เป็นการศึกษาทบทวนหลักการพื้นฐานของประเมินผลกระทบต่อสุขภาพ เครื่องมือการประเมินความเสี่ยงทางสุขภาพฉบับร่างได้พิจารณาโดยผู้ทรงคุณวุฒิด้านการประเมินความเสี่ยงทางสุขภาพ ระยะที่ ๒ เป็นการทดสอบและประเมินผลเครื่องมือในโรงงานผลิตภัณฑ์ซีเมนต์ การพัฒนาโครงเครื่องมือฉบับร่างสอดคล้องตาม ๕ ขั้นตอนของการประเมินความเสี่ยงทางสุขภาพ คือการกลั่นกรองเบื้องต้น (Screening) การกำหนดขอบเขต (Scoping) การประเมินผลกระทบ (Appraisal or assessment) การจัดทำรายงานและทบทวน (Reporting and reviewing) และ การติดตามตรวจสอบและประเมินผล (Monitoring and evaluation) มีการประเมินความเสี่ยงทางสุขภาพทั้งเชิงคุณภาพและปริมาณในโรงงานและชุมชนใกล้เคียง การศึกษาเชิงภาคตัดขวางนี้ (Cross-sectional study) มีการเก็บตัวอย่างอากาศในระดับบุคคลและสิ่งแวดล้อม และการวัดสมรรถภาพปอด

ในการศึกษานี้เครื่องมือถูกพัฒนาเน้นการประเมินความเสี่ยงทางสุขภาพและผลกระทบตามปัจจัยข้อกำหนดทางสุขภาพ (Health determinants) ค่าร้อยละการประเมินจำแนกเป็น ๕ ระดับ คือ ความเสี่ยงระดับที่เล็กน้อย ต่ำ ปานกลาง สูง และสูงมาก เครื่องมือประเมินผลกระทบต่อสุขภาพโรงงานผลิตภัณฑ์ซีเมนต์นี้สามารถนำไปประยุกต์ใช้ได้ในการประเมินผลกระทบต่อสุขภาพ การประเมินผลกระทบทางสุขภาพโดยอาศัยการประเมินในสองมิติ คือ การประเมินระดับความเสี่ยงจากการสัมผัสและผลกระทบทางสุขภาพโดยใช้ระดับค่าประเมินความเสี่ยงทางสุขภาพเป็นระดับคะแนนความเสี่ยงโดยการวัดเชิงปริมาณ

ผลการศึกษาพบว่าค่าระดับคะแนนความเสี่ยงทางสุขภาพจากการประเมินในกลุ่มประชากรที่อาศัยใกล้โรงงานในรัศมีไม่เกิน ๒ กม. มีค่าระดับความเสี่ยงทางสุขภาพ (๒๐ คะแนน) สูงกว่ากลุ่มประชากรที่อาศัยอยู่ไกลจากโรงงานในรัศมี ๕ กม. (๑๐ คะแนน) แต่พบว่าพนักงานในโรงงานมีค่าระดับความเสี่ยงทางสุขภาพสูงกว่า (๔๐ คะแนน) โดยสรุปเครื่องมือการประเมินความเสี่ยงทางสุขภาพนี้สามารถนำไปประยุกต์ใช้ในการประเมินความเสี่ยงทางสุขภาพได้ แต่อย่างไรก็ตามควรมีการศึกษาพัฒนาเพิ่มเติมอีก การศึกษาครั้งนี้มีข้อเสนอแนะคือขั้นตอนการการประเมินความเสี่ยงทางสุขภาพควรเพิ่มขั้นตอนการเตรียมการก่อนการประเมินเพื่อรวบรวมข้อมูลพื้นฐานที่จำเป็น ผู้ทรงคุณวุฒิหรือคณะกรรมการที่ปรึกษาควรเข้ามามีส่วนร่วมในขั้นตอนนี้ ผู้มีส่วนได้ส่วนเสีย (Key stakeholders) และผู้ที่ได้รับผลกระทบ ควรเข้าร่วมพิจารณาทุกขั้นตอนตั้งแต่ก่อนดำเนินโครงการจนตลอดจนการติดตามและประเมินผล

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต ....

ปีการศึกษา 2555 ลายมือ อ.ที่ปรึกษาวิทยานิพนธ์หลัก ....

5379205153 : MAJOR PUBLIC HEALTH

KEYWORDS : HEALTH IMPACT ASSESSMENT, CEMENT FACTORY, HEALTH RISK ASSESSMENT, RESPIRATORY HEALTH, OCCUPATIONAL HEALTH

PHAYONG THEPAKSORN: DEVELOPING HEALTH IMPACT ASSESSMENT TOOLS: A CASE STUDY OF CEMENT FACTORY IN NAKHON SI THAMMARAT PROVINCE, THAILAND

ADVISOR : ASSOC.PROF.SATHIRAKORN PONGPANICH, Ph.D., 189 pp.

The main objective of this study was to develop health impact assessment tools (HIA) specific to the roofing fiber cement industry. This study has been conducted in two phases. The first phase is a descriptive review and basis of the study. The drafted HIA tools were appraised by HIA experts. The second phase is the implementation and evaluation of HIA tools through pilot testing in a fiber cement factory. The developed HIA tools were drafted according to the 5 steps of HIA approaches including: screening, scoping, appraisal or assessment, reporting and reviewing, and monitoring and evaluation. Both qualitative and quantitative measurements were used for assessing the occupational exposure risks in the factory and the community nearby. A cross-sectional study was utilized. Personal and environmental samplings and spirometry measurements were also collected.

In this study, the HIA tools focused on risks and impacts on human health based on specific health determinants. Percentage values were categorized into five groups as follows: minimal health risk, low, moderate, high, and very high impacts on human health. The appraisal for HIA in fiber cement factories could lead to the employment of systematic determination of potential health impacts. This study employed the impacts on human risks into two-dimensions: health risk matrix of exposure rating and health effect rating. The health risk matrix score (HRM) was determined through the quantitative measurements on the health risk assessment.

The affected populations in the near group (2-km; score = 20) have a HRM score slightly higher than the far group (5-km; score = 10), but the employees had a higher HRM score (score = 40) than both of the affected populations. In conclusion, the application of the HRM score as a HIA tool for roofing fiber cement factories could be employed for quantitative risk assessment. However, further study is warranted. This study suggested that the HIA conducting should be initially started with a preparation stage to gather important data and resources. Experts and/or the advisory committee should also step in at this stage. Stakeholders and affected populations should be involved in all stages from the pre-step through the monitoring and evaluation stages.

Field of Study ....Public Health.......... Student's Signature ....
Academic Year ....2012.......... Advisor's Signature ....

ACKNOWLEGEMENTS

I would like to express my gratitude to Assoc.Prof. Dr.Sathirakorn Pongpanich, for his support, motivation, enthusiasm and immense for critical thinking and knowledge. I also would like to thank Asst.Prof.Dr.Wattasit Siriwong for his lighting up ideas, suggestions and providing additional resources. I also thank the dissertation committee, Dr. Robert Sedgwick Chapman for his suggestions and feedback.

This research was supported by a 90th Year Chulalongkorn Scholarship and partially funded by the Fogarty International Center, National Institutes of Health (D43 TW007849).

I would like to thank the manager and employees at the roofing fiber cement factory and populations near the factory who were participated in this study. Most importantly, with the great support of my family, I would like to thank for their patient. My thanks go to my wife, Elizabeth and my daughter, Sirada for their patient while I am staying in Thailand. Lastly, I would like to thank my mother for her long time supports. This research is dedicated to my father for his compassion.

CONTENTS

Page

Page

LIST OF TABLES

Page

Page

Page

LIST OF FIGURES

Page

ACRONYMS

HIA	Health Impact Assessment
HIRA	Hazard Identification and Risk Assessment
HOC	Hierarchy of Control
HRA	Health Risk Assessment
OEL	Occupational Exposure Limit
PPE	Personal Protective Equipment
SEG	Similar Exposure Groups
HEG	Homogeneous Exposure Groups

CHAPTER I
INTRODUCTION

This initiated project was an integrated study on examination and developing the Health Impact Assessment (HIA) tools: a case study of cement factory in Nakhon Si Thammarat Province, Thailand. Specifically, the HIA tools were developed and conducted through the fiber roofing cement factory.

The attempts to integrate HIAs have been gradually progress in Thailand for the past decade [1-4]. However, the development has mainly been focused and restricted to process issues according legislation, including policy engagement and community involvement, while the evidence base has been relatively limited and neglected[1,3].

This chapter provides research background and significance, specific aims, research questions, scope of study, and the definition of terms in this study. The main objective is to document a developed guideline procedure and lessons-learned specifically in roofing fiber cement industry with implications for identifying guideline practices in the future.

1.1 Background and Rationale

The overall purpose of this study is to develop tools for health impact assessment (HIA tools) in roofing fiber cement factory in Thailand. The HIA tools will be proposed and used as a protocol and guideline for health risk assessment (HRA) in roofing fiber cement factory.

The HIA tools were developed and implemented for testing, monitoring and evaluating the capacity. The first phase of HIA tools was to develop the daft tools and guidelines and addressed five sequential steps of proposed HIA approaches, including 1) screening to determine whether an HIA should be conducted, 2) scoping to outline the specific focus of the HIA and methodologies to be used, 3) profiling baseline information and impact assessment to analyze relevant evidence in order to make qualitative and quantitative assessments of potential health impacts, 4) report preparation to synthesize the results and communicate them to target populations (e.g. policy-makers, stakeholders, and community representatives), and 5) monitoring and evaluation. The HIA tools were considered according to health determinants including environmental impacts, social and socioeconomics impacts, and health care services and their impacts. The draft of HIA tools was reviewed and evaluated by HIA experts.

The second phase was implemented and evaluated the HIA tools through the roofing fiber cement factory in Nakhon Si Thammarat Province and the community surrounded the factory. This phase was integrated between questionnaire interviews of key stakeholders and HRA procedures. The questionnaire interviews were conducted following the HIA procedures and focused on, for example, community concerns, environmental issues, and health risk issues. The HRA was analyzed in both qualitative and quantitative methods. The qualitative measurements were included a walk-through survey, health risk rating, in-depth interviews, and health risk matrix whereas quantitative measurements were conducted using health questionnaire interviews and physical examinations, health impact assessment screening for health determinants, and personal and environmental and samplings. The HIA tools are addressed and used as guideline for HRA of stakeholder expectations, ethical obligations, legal requirements and universal principles of sustainable development of the roofing fiber cement industry.

Air pollutants such as dust, particulates, and chemicals are one of the major environmental problems, especially in community located near industrial areas. It can affect our health and damage the environment in several circumstances [5-7]. A number of studies have reported the associations between cement dust exposure and health effects and health related symptoms [8-19]. Where the community is aware of the cement industry, it is usually in an environmentally negative context such as cement dust exposure and other pollution emissions [31]. In roofing fiber cement productions and pollutant emissions, cement dust and chemical uses may cause respiratory health risks and other ill health. These concerns have been paid attention by populations in the community who are living in vicinity of the factory.

Recently in Thailand, there have been limited and less well-documented on practical procedure HIA tools and guidelines for HRA in roofing fiber cement factory and related industries. There were no consensuses on guideline or protocol for HIA in roofing fiber cement factory [2, 4]. This study has been incorporated previous existing review studies, expert judgment and HIA assessment activities through collaboration among key stakeholders.

1.2 Research Objectives

General objective to:

Develop HIA tools for roofing fiber cement industry

Specific objectives to:

1.2.1 Review the integrated HIA into environmental health assessment (EIA), existing legal requirements of health risk analyses, and the lessons –learned for integrating HIA within EIA process in Thailand.

1.2.2 Examine occupational dust exposure levels and the health risk hazards in the roofing fiber cement processing industry.

1.2.3 Assess self-HRA among populations living in the vicinity of a roofing fiber cement factory.

1.2.4 Examine the associations between respiratory symptoms and patterns of pulmonary dysfunction among roofing fiber cement employees.

1.2.5 Disseminate findings and develop the HIA guideline practice for the fiber cement factory industry.

1.3 Research Questions

1.3.1 What are the existing standard procedures and practices for HIA in roofing fiber cement industry?

1.3.2 What are the health determinants of HIAs for roofing fiber cement industry?

1.3.3 What are the occupational health risks among roofing fiber cement employees?

1.3.4 What are the characteristics of appropriate tools and guideline practices for HIA in roofing fiber cement industry?

1.4 Scope of Study

This study was conducted at one of the major roofing fiber cement factories in Nakhon Si Thammarat Province. The participants included key stakeholders including experts from university professors, public and private representatives, employees, community leaders and populations nearby the factory. This study was conducted between September 2010 and February 2012.

1.5 Significance of the Study

The development of integrated approaches or standard practices to safety and health risks is no longer isolated from employees, product safety, and public health safety, and whereby the safety and health responsibilities of companies are no longer limited to their own site [20-21].

There is relatively new for Thais' businesses for applying and implementing HIA into EIA compared with developed countries such as European countries, US, Australia and Japan [22-23]. Recently, there are efforts from government in supporting HIA in EIA approaches, standards of good governance, environmental and social issues by promulgating criteria and scope of business types based on project and program in 2009 [2,4]. One of the critiques facing the HIA development process is the lack of consensus criteria and practical guideline for implementation, monitoring, and evaluation as well as participation and engagement with key stakeholders [1, 3].

A few studies and implementations of HIA are actually integrated as in part of EIA procedure [4, 24]. In theory, integrating HIA into EIA could save efforts and costs although this is another issue which needs to be tested. However, HIA is not a method by which making decisions or judgments are made by prone sophisticated methods such as quantitative based on specific quantification and calculation [25-26]. Therefore, HIA cannot directly implicit use for decision makers for judging but could be used for supporting their decision for gain positive aspects and reduce unwanted health risks for involved populations and community. In addition, most HIA address concerns by and/or affects by community. Therefore, their participations in the HIA process are vital [4]. Advantages of integrating HIA into EIA is to build on existing data and analysis, avoids duplication and redundancy and fragmenting analysis. In addition, it further engages community and addresses community concerns. In addition, it can be conducted concurrently.

Even though a few of HIA and EIA activities have been regularly previously endorsed in Thailand [3,4], there are limitations in consensus among experts, governmental decision makers, the employers, employees, and community leaders about the scope of HIA program in EIA procedure. This project has been incorporated HIA activities through collaboration between key stakeholder informants, employer and employees, and the community participants. This implementation expects are of substantial benefits to the government agencies, employers, and related stakeholders for conducting and evaluation HIA activities as a protocol and practical guideline. It also has advantages for exposed workers as they confront the challenges of occupational risks and raise awareness of the owner and community to occupational health risks.

There are a number of difficulties for establishing HIA and improvement in public health as well as demonstrating the health outcomes due to a large number of confounding factors [25, 27]. Mostly HIA are performed in a qualitative or semi-quantitative way [25]. It rarely has evidence base to perform complex in analyses and also is limited [27]. Quantification of effects in HIA is relatively rare. Therefore, HIA could be benefits from a more quantitative approach but this require availability of data and access to valid, usable, and simulation models. To date only a limited number of initiatives have explicitly sought to build HIA tools and guidelines in Thailand, especially in roofing cement factory. This therefore appears to be benefits that would justify considerably more attention from those with an interest in HIA tools use and application for roofing fiber cement factory.

1.6 Overview of the Dissertation

This study investigated and developed appropriate HIA tools for roofing fiber cement industry through model development in several steps according to HIA approaches.

In chapter I this study introduces the general background. This chapter provides research background and significance, specific aims, research questions, scope of study, and the definition of terms in this study. The chapter II describes the descriptive relevant review and concept basis for the study. This literature review is explained the basic concept of HIA, HIA experiences from international and domestic contexts as well as the health risk assessment in roofing fiber cement manufacturing process and work environment. The chapter III focuses on research methodology. The intensive literature review regarding HIA for roofing fiber cement industry in both domestic and internationals were explored. This study is integrated different aspects of epidemiological study, qualitative and quantitative analysis methods. The descriptive analysis is purposively to assess health impact into three dimensions, including psychological, social, and spiritual aspects. The qualitative assessment was developed based on health consequence rating and health risk matrix. The quantitative method was assessed through hazardous risk assessment. The chapter IV presents the results in both qualitative and quantitative methods. The descriptive characteristics of study are included both phases of Phase I: developing tools and guideline for roofing cement industry and Phase II: implementation and evaluation of HIA guideline. Finally, the chapter V provides discussions of the findings. The limitations of the study are discussed. The conclusions were presented according to our study procedures as well as the future research is recommended.

1.7 Conceptual Framework and Box Diagram Methodology

The develop HIA tools for roofing fiber cement factory have been demonstrated into two phases, including 1) develop draft tools and assess the HIA tools through key informant questionnaire interviews with HIA experts and 2) implement and evaluate the HIA tools through pilot testing in fiber cement factory in both qualitative and quantitative measurements for quantifying the occupational exposure risks in the factory and community nearby, particularly health hazards Finally, disseminate findings on occupational exposure risk impact assessment and HIA tools for determining the applicability to use in cement factory (Figure 1.1).

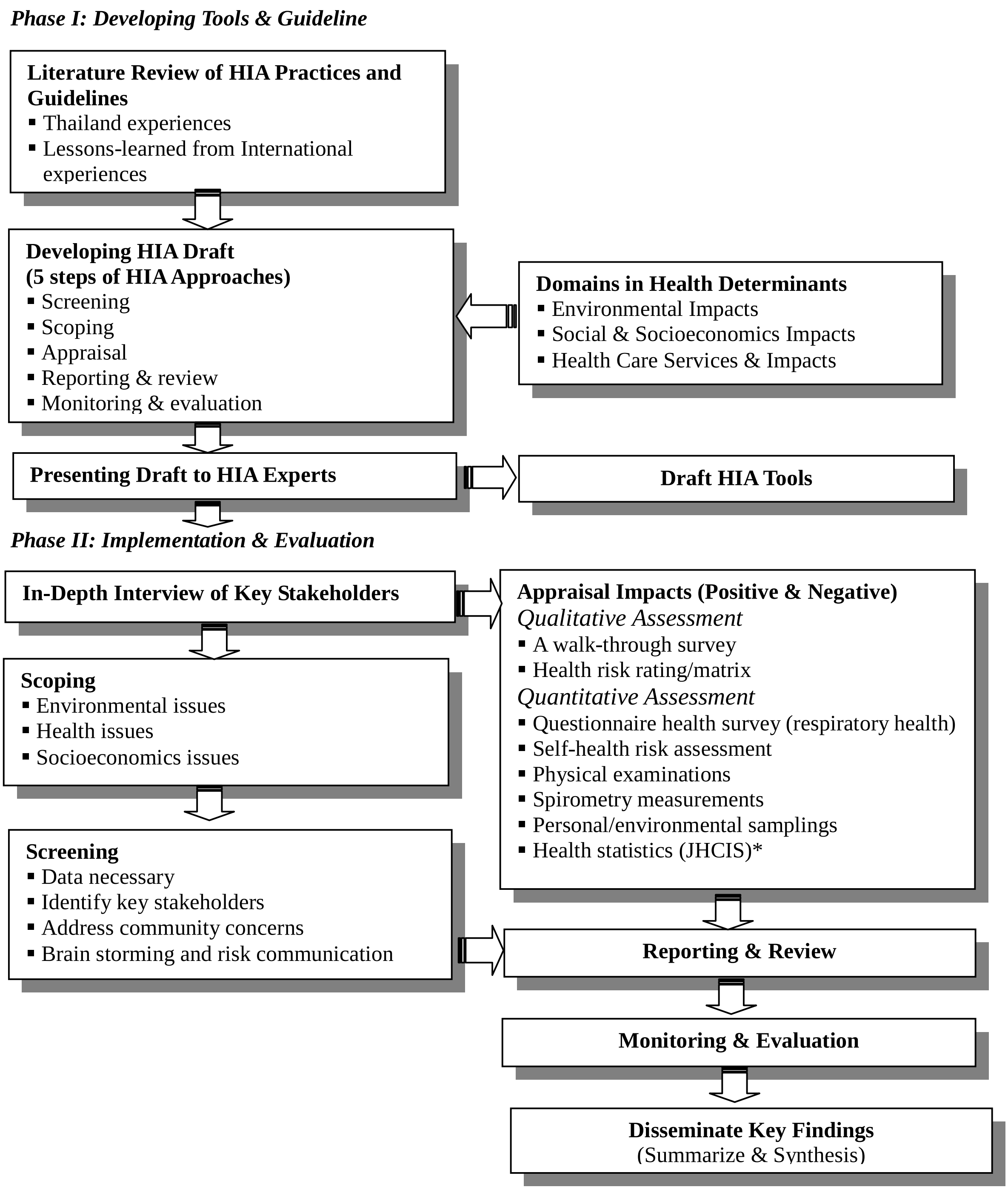


Figure 1.1 Box diagram for the development of a methodology for HIA in this study

*The descriptive characteristic data for assigned populations were extracted from the Java Health Center Information System (JHCIS) according to basic data classified into 21 family folders for out-patient registries

1.8 Term Terminology

The following information was taken from the WHO Glossary of Terms and selected references [28-30].

Determinants of health

"Determinants of health are factors which influence health status and determine health differentials/variations or health inequalities. They are many and varied and include, for example, natural biological factors, such as age, gender and ethnicity; behavior and lifestyles, such as smoking, alcohol consumption, diet and physical exercise; the physical and social environment, including housing quality, the workplace and the wider urban and rural environment; and access to health care. All of these are closely interlinked and differentials in their distribution lead to health inequalities".

Health Impact Assessment

"A combination of procedures, methods, and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population. HIA identifies appropriate actions to manage those effects".

Healthy public policy

"Healthy public policy is a key component of the Ottawa Charter for Health Promotion. The concept includes policies designed specifically to promote health (for example banning cigarette advertising) and policies not dealing directly with health but acknowledged to have a health impact, for example, transport, education, economics".

Mental Health

"Mental health is a state of complete physical, mental and social well-being, and not merely the absence of disease. It is related to the promotion of well-being, the prevention of mental disorders, and the treatment and rehabilitation of people affected by mental disorders.

Social Determinants of Health

"Social determinants of health are the economic and social conditions and their distribution among the population that influence individual and group differences in health status".

Spiritual Health

"Spiritual health is a: state of being where an individual is able to deal with day-to-day life in a manner which leads to the realization of one's full potential; meaning and purpose of life; and happiness from within. A need was felt to evolve an operational definition on the basis of the suggested definition above in order to make it compatible to the development of personality framework".

Personal Airborne Dust Sampling

Personal airborne dust sampling involves direct connection of an integrated monitoring device to workers. The device is used to collect airborne dust sample and record the intensity of airborne dust in the specific areas and during specific tasks. The sampling device is positioned in the work's breathing zone within 9-12 inches distance from worker's nose and mouth.

Area Airborne Dust Sampling

Area dust sampling is focused on a specific location or a stationary location. Stationary area samples are collected at a height of approximately 4 ft from the floor or the ground.

FVC (Forced Vital Capacity)

This is the total volume of air expired after a full inspiration. Patients with obstructive lung disease usually have a normal or only slightly decreased vital capacity. Patients with restrictive lung disease have a decreased vital capacity.

FEV1 (Forced Expiratory Volume in 1 Second)

This is the volume of air expired in the first second during maximal expiratory effort. The FEV1 is reduced in both obstructive and restrictive lung disease. The FEV1 is reduced in obstructive lung disease because of increased airway resistance. It is reduced in restrictive lung disease because of the low vital capacity.

FEV1/FVC

This is the percentage of the vital capacity which is expired in the first second of maximal expiration. In healthy patients the FEV1/FVC is usually around 70%. In patients with obstructive lung disease FEV1/FVC decreases and can be as low as 20-30% in severe obstructive airway disease. Restrictive disorders have a near normal FEV1/FVC.

1.9 Ethical Considerations

This study was approved by the ethic committee of the Chulalongkorn University Review Board (COA No.029/2555; research project 189.2/54). Permission to conduct the study was granted by the factory manager. All of the participants received a clear explanation of the purpose of this study and agreed to participate via signed consent forms.

CHAPTER II
LITERATURE REVIEW

This chapter described the descriptive relevant review and concept basis for the study. This literature review can be used to understand about the basic concept of HIA, HIA experiences from international and domestic contexts as well as the health risk assessment (HRA) in roofing tiles fiber-cement manufacturing process and work environment.

This chapter divided into six sections. The first section presented the basic concept of health determinants and data sources for conduction HIA in this study. The second section was overview of international work in HIA and their experiences. The third section described the HIA development and experiences in Thailand. The fourth section described HIA methodology and procedure for implementing HIA. The fifth section was summarized HIA quantifications and evaluation methods. The sixth section was HRA that employed for HIA. Lastly, the roofing tile fiber-cement manufacturing process and work environment. Also, the workplace hazards and observed exposure risk have been reviewed (Table 2.5).

2.1 Basic Concepts about Health and Health Determinants

In developing health impact assessment guideline and procedures, health determinants have been determined as fundamental inputs for effectively incorporate health considerations into HIA [22-23]. Health is not only defined and clearly indicates more than a state of physical, mental, and social well-being and the absence of sickness and disease, but it also involved with social, economic, and political aspects [32]. Health determinants can be classified into seven domains including 1) individual health determinants, 2) social determinants, 3) public health, health care providers and services, 4) environment health services, 5) environment, 6) health status, and 7) health impacts.

2.2 Overview of International Background HIA Development and Experiences

In the mid 1960's, The World Bank has made use of cost benefit analysis as tool to aid decision whether to proceed with investments in developing countries which, because of the low level of economic development and absent infrastructure, tended to have enormous impacts on biodiversity and the environment. However, it was inadequate and failed to take substantial aspects of health risk assessment and impacts into account for the consequences for biodiversity and the environment [33].

In 1969, the US introduced the Environment Protection Act 22 which requires an environmental impact assessment of all projects in the US and all projects funded by US financial aid. This requirement was rapidly followed by other countries [34]. EIA was implemented in the UK in 1988. In many ways, the development of health impact assessment has been linked to or modeled on environmental impact assessment. To address environmental impact assessment is required the skills and knowledge of integrated several disciplines [23].

The discipline of HIA in a subset of EIA is actually focusing on any activities that contribute to health risks. In Canada, British Columbia government published a tool kit consisting of questions to help Government departments to identify the health implications of each policy [22].

HIA Development and Standard Practices

HIA is one approach to conducting a comprehensive health analysis. It is an approach or procedure that can help to identify, prediction, and consider the potential health risk impacts on a defined population in both positive and negative aspects. This method of evaluating is likely effects of the policies, initiatives and activities on potential health risks and helping to develop recommendations to maximize health gain and minimize health negative risks. Therefore, the set of evidence-based according expert judgments following guidelines and recommendations gears to informing the decision making process [23]. In addition, HIA plays a crucial role as public policy tool since it can be used for promoting social equity, sustainability and healthy public policy, decision making in public health and emphasize social and environmental justice [35].

Although there are no single agreements and protocols or guidelines of doing HIA, there is a developing consensus from several developed countries about the core elements or stages of the process, including 1) scanning or screening for deciding whether to undertake an HIA into identified projects or programs, 2) scoping or proposing term of reference (TOR) for planning how to undertake an HIA in a given context, 3) profiling an appraisal or assessment to identifying and considering a range of evidence for potential impacts on health, 4) developing recommendations for deciding on and prioritizing specific recommendations for key stakeholders and the decision makers and 5) report preparation to synthesize the results and communicate them to target populations, including policy-makers, governmental bodies, stakeholders, and community [32].

HIA assesses three main products including a profile of baseline conditions (baseline health status and factors known or suspected to influence health), a judgment on potential health conditions (an evaluation of their certainty and significance), and an evaluation of management strategies for any identified adverse health impacts–in the form of decision alternatives, policy design changes, mitigation of specific impacts, or other related policy recommendations [32].

2.3 Health Risk Assessment (HRA)

HRA has been employed in part of HIA quantitative assessment. The baseline HRA is reviewed in the operation phase including the process workflow and physical inspection of the project. The main objectives of HRA are to identify hazards and their harmful health effects, exposed target population, and exposed procedure and tasks. The assessment and measurements to verify exposure are endorsed HRA techniques such as personal and area air samplings, biological monitoring, and physical samplings to analyze the potential of health risks of the hazardous exposure (Figure 2.1). The effective of existing control measures is analyzed for workers' health protection. The priority setting has been determined of effective methods and exposure control. The development and implementation plan is incorporated for monitoring exposure risks and reviewed existing risk control action plan. The targeted HRA determines in both qualitative and quantitative measurements using validated statistical sampling techniques, and assessment methodology as well as assessing whether proposed or existing control measures are adequate and appropriate to control health risks to below agreed upon standards, e.g. occupational exposure limits (OELs) as well as continuous HRA has been managed as part of the continuous implement process within the overall occupational health risk action and management system and through existing set of control measures, where present. The amendment of existing control action plan and alternative control measure is provided as well as maintain accurate and systematic HRA records [20, 23, 36].

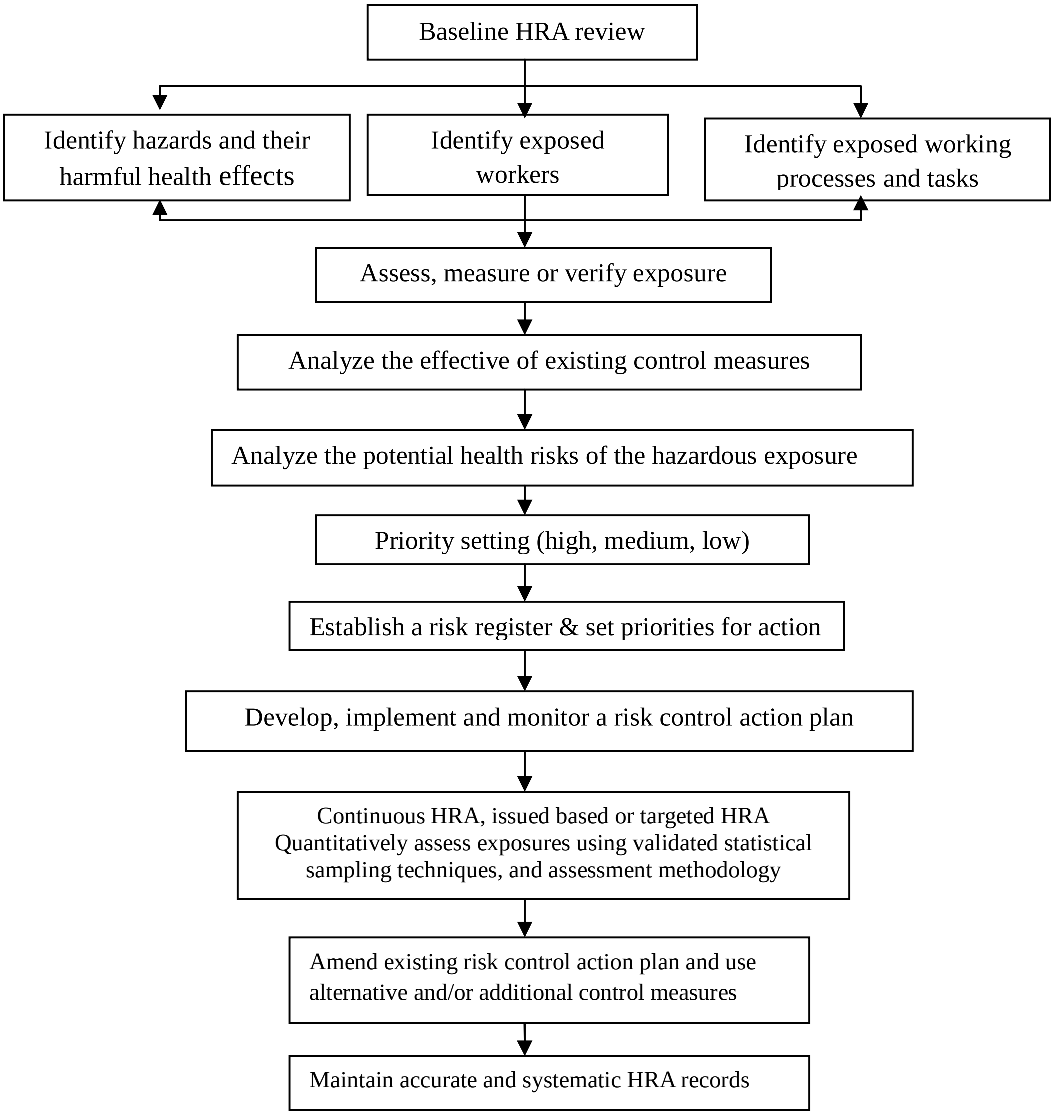


Figure 2.1: Schematic Overview of the HRA Procedure

HRA in Relations to HIA

In theory, Health Risk Assessment (HRA) overlaps significantly with HIA whereas HRA is used in much more limited manner and is not a comprehensive health analysis in practice. HRA in practice is purpose to quantify the health effects from a change in exposure to a particular hazard whereas HIA is objective to make evidence based judgments on the health impacts of a decision and to make health-promoting recommendations. HRA focuses on one contaminant outcome pathway (diesel exposure and lung cancer) and ignores existing inequities and vulnerabilities while HIA applies holistic approach to predict environmental and social exposures and impacts and takes into account existing health inequities and vulnerabilities. HRA uses modeling to quantify all risks, but HIA is rather using quantitative and qualitative methods [22-23, 37].

A number of developed countries are undertaking HIA promulgation as guideline and procedure, for example, UK, US, Canada, Australia, and New Zealand [22-23,32]. An example has been developed in Canadian Government, where the British Columbia government agreed that HIA would be in part of the approval process for government policy, programs, and legislation [22].

Improving the occupational health and safety has been recognized as a crucial element for prevention and protection workers' health. Several frameworks have been developed and implemented for promoting occupational health and safety and also preventing occupational risks for workers in work environments. There are a number of occupational health and safety standards, including the International Standards Organization (ISO; e.g. ISO 9000 and ISO 14000), British Standard (BS 8800), and Occupational Health and Safety Management System (OHSMS 18000:1999) [ISO, 2011]. In addition, The International Labor Organization (ILO) adopted OHSMS model (ILO-OSH: 2001) to address developing national guidelines, especially for small and medium organizations [21]. This model consists of 16 fundamental developments, including 1) planning for hazard identifications, risk assessment and risk control; 2) monitoring the implementation of legislation and other requirements; 3) awareness and competent training; 4) consultation and communication; 5) documentation and data control; 6) checking and corrective action; and management review. In Thailand, the Ministry of Labor and the Ministry of Industry cooperated in setting up the Thai Industrial Standards on Occupational Health and Safety Management system (TIS 18000) in 1999 [38].

Risk to health from environmental health hazards can be estimated using qualitative and quantitative strategies. Qualitative health risk assessment as a prioritization tool is used in situations where there is difficulty in obtaining accurate data and records on the factors that determine health risks. Experience in developing countries indicates the usefulness of qualitative techniques in environmental health risk assessment.

Qualitative HRA involves the following steps: a) Identification of adverse health consequences on the human receptors and rating them based on the severity of ill-health or health consequence rating, b) Estimation of the probability of occurrence of the exposure incident. This can be estimated using the exposure rating technique or the incident potential rating technique, and c) Integration of the adverse health consequence rating with either the exposure rating or the incident potential rating to come up with a health risk prioritization matrix that becomes the basis for planning and prioritization of control and preventive measures. The health consequence rating, incident potential rating and exposure rating as well as the health risk assessment matrix are explained in Table 2.1 [23, 37].

Table 2.1 Qualitative health risk assessment (HRA)*

Type	Criteria	Definition
Health Consequence Rating	1	Slight Injury/Illness: Not affecting work performance or activities of daily living, nor cause disabilities or morbidities to members of the community.
	2	Minor Injury/Illness: Affecting work performance or activities of daily living (schooling, cooking, washing clothes) or a need to take a few days off to fully recover the activities of daily living. Agents with limited health effects which are reversible (e.g. skin irritations, food poisoning bacteria)
	3	Major Injury/Illness: Resulting in a permanent partial disability or affecting work performance or activities of daily living of vulnerable members of the community in the long term. Agents capable of irreversible damage without serious disability (e.g. noise, ergonomic hazards)
	4	Permanent total disability or fatality (small exposed population) Agents capable of irreversible damage with serious disability or death both to workers and vulnerable members of the community (e.g. acids, and alkalis in the laboratory, chemicals with known human carcinogen released to the environment)
	5	Multiple fatalities (large exposed population): Agents with potential to cause multiple fatalities (e.g. chemicals with toxic effects and known human carcinogens especially if released) into the air, soil and water media (heavy metals, pesticides).
Incident Potential Rating	Very Low (A)	Unlikely to happen
	Low (B)	Theoretically possible to happen but no report of its occurrence is available locally or abroad.
	Medium (C)	Has happened once in Thailand or abroad in an industry or development quite similar to the project being proposed
	High (D)	Has happened more than once in Thailand or abroad in an industry or development quite similar to the project being proposed
	Very High (E)	Has happened during the operation of similar development owned and operated by the project proponent in other parts of Thailand or abroad
Exposure Rating	Very Low (A)	Exposures are negligible.
	Low (B)	Exposures are controlled and likely to remain so in accordance with ideal preventive measure criteria.
	Medium (C)	Exposures are currently controlled and meet control measure standards, but control cannot be assured.
	High (D)	Exposures are not adequately controlled to meet standards and continuously or regularly exceed occupation and / or community limits.
	Very High (E)	Exposures are excessive and will almost certainly result in health damage to workers or community residents exposed.

*The qualitative HRA is based on health consequence rating, incident potential rating and exposure rating [23, 37].

Table 2.1 Qualitative health risk assessment (HRA) (cont.)

Type	**Criteria**	**Definition**				
Health Risk Matrix	*Consequence Rating*	*Exposure rating or Incident potential rating*				
		Very Low (A)	Low (B)	Medium (C)	High (D)	Very High (E)
	Slight injury/illness	9	8	7	6	5
	Minor injury/illness	8	7	6	5	4
	Major injury/illness	7	6	5	4	3
	Permanent total disability /fatality	6	5	4	3	2
	Multiple fatality	5	4	3	2	1

In recent decades, health impact assessment methodologies have been employed to predict and estimate the influence of potential health impacts and/or health consequences of implementing programs, projects, and policies by comprehensively identifying relevant health determinants and their consequences. They have been demonstrated to be an effective tool for health promotion strategies and policies. At the beginning, HIA reflects the increasing need to enhance decision-making and address health issues according to health determinants (the social, environmental, cultural and political influences on population health) [26, 39].

HIAs have been defined by the World Health Organization (WHO) as "A combination of procedures, methods, and tools by which a policy, program or project may be judged as to its potential effects on the health of population and the distribution of effects within the population" [32]. HIA is also important for addressing population health and health inequities because it tackles the health determinants. There are five main elements including biological factors such as age, sex, etc., individual lifestyle factors such as physical activities and eating habits, social and community networks, living and working conditions, and general socioeconomic, cultural and environmental conditions [40].

Recently, several countries have been extensively experiences in which HIA can assess and add value to strategic policy and planning decision-making processes such as European countries, Southeast Asia, Australia, New Zealand and the USA [41]. In addition, HIA processes in many countries incorporate active participation of interested stakeholders. Moreover, Australia, New Zealand, Thailand, and Canada have integrated

HIA into project specific EIA legislation [42]. HIA can be undertaken at a number of decision-making levels, for example, HIA may be undertaken on proposals for project or program level, national policy level or even international policies such as the Common Agricultural Policy [43].

The ultimate goal of HIA conducting is to influence and support decision making to minimize the harm and maximize the health benefits of proposals by raising and informing the general awareness among decision makers that their actions affect on population health. In addition, it helps those potentially affected by decisions to participate or agree in proposal strategy and plan [44].

There are three main stages of HIA conducting, including retrospective, concurrent, and prospective methods. Ideally, prospective HIA conducting is to predict and estimate the health consequences of a proposal before it has been implemented. This helps the policy makers or governmental bodies for finalizing their decision making beforehand. A concurrent HIA involves monitoring an intervention during implementation. It has advantages when health impacts are expected but their nature and severity are uncertain whereas a retrospective HIA takes place after the proposal or project has been implemented which plays in role to provide evidence for future similar interventions [44].

HIA in Thailand

There have been efforts for development and implement HIA in Thailand for years. The constitution established in 1997 provides an opportunity for civil participation in the process of decentralization of decision- making and resource allocation. Later in 2007 , the constitution has been promulgated in the article 67 “Implementing any projects or activities in which could affect the community cannot be endorsed except those projects have already studied the feasibility of environmental impact assessment and health risk assessment in community and public hearing from stakeholders and community” [3-4]. The HIA is one crucial part of EIA has been introduced in Thailand for years. Initially, the government has promulgated the EIA method for 10 types of business and industries that had to report EIA in 1981. Later, the government has been expanded for EIA assessment covered 22 types of business and industries in 1990. There are four main core elements for EIA including physical and biological aspects, invaluable and quality of life. Initiative HIA has been primarily carried out by Institute of Health System Research in 2003. It was focusing on health participatory learning for health promotion, not considering on EIA as an approval mechanism [4]. In Thailand, HIA process depends on the development of four pillars including using appropriate analytical frameworks for a continuously participatory learning process, an effective institutional structure for facilitating HIA implementation, impact and outcome, technical experts and experiences to support HIA implementation, and fostering capacity and advocating healthy public policy. In 2006, the Office of Natural Resources and Environmental Policy and Planning (ONREPP) has been promulgated for EIA in assigned projects. It was included HIA in EIA approval process. Presently, it’s promulgate has been covered 34 types of business and industries in 2008.

The development of HIA in Thailand has been attempted and promoted from several Thailand’s agencies, especially governmental bodies. Even though HIA is still a relatively new and developing approach in Thailand, there are evidences of increasing activities in both national and local level. There are a number of centers including the Health System Institute (HSRI) and HIA division of Department of Health, Ministry of Public Health (MOPH), Health Policy and Planning of The Ministry of Natural Resource and Environment (MONRE), and higher educational institutes and universities.

According to The Thai Constitution 2007 and the Thai National Health Act 2007 are addressing on HIA, covering the rights of Thai citizens to participate in the HIA process, as well as requiring the guidelines and procedures for HIA [2]. Within the government bodies, the Ministry of Public Health (MOPH) has encouraged the regional and provincial health offices for HIA activities since 2002 [3]. The Ministry of Natural Resource and Environment (MONRE) also incorporated HIA as a key component to EIA reform and enforcement. The use and application of HIA have been increasing across agencies and all sectors in Thailand since then. The detail in HIA development covers several aspects including industrial and energy policies, agricultural, land-use and chemical uses policies, as well as HIA capacity buildings [3-4]. The HIA tool can be used for local agencies and communities as community HIA (CHIA) in developing healthy public policy and health protection as well as capacity buildings and community participation. The process is linked to customs, traditions, and the ways of life and beliefs of local communities.

Table 2.2: The use of people's rights in assessing health under Section 67 and Section 11[2-3]

Item	Section 67 (Constitution)	Section 11 (National Health Act)
1. Application of HIA	For project or activity that may have serious, adverse repercussions.	For public policy (more extensive than activity or project)
2. People's Rights	- Can express views regarding activity or project as a stakeholder and as a citizen. - Community is entitled to sue government agency, state or state enterprise agency, local government agency or other juristic state agency in case of failure to carry out duty specified in Section 67.	- Entitled to ask for a health impact assessment from public policy. - Can take part in the process of health impact assessment. - Entitled to receive data, explanation and reason from state agency before permission is given for a project or activity, or before a project or activity is implemented that may affect the health of the individual or community
3. Related organizations	Independent health and environment organizations	Office of the National Health Commission

2.3 HIA Methodologies and Model for Assessing HIA

According to WHO and international HIA experiences [20, 22-23,32, 42, 47], methods have been employed and integrated several approaches. These can be classified into three categories in which each of them has its own strengths and limitations (Table 2.3)

Table 2.3: Descriptive characteristics of HIA model and examples

Methods	Descriptive characteristics	Assessment	Strengths and limitations
1. Community participatory approach	This approach is focusing on stakeholder involvement and public participation in decision-making. It emphasizes community participation and consensus-based decision making	Qualitative assessment	It uses to facilitate better public decision-making rather than indicating which decision is better. It is a fairly efficient process covering a broad range of potential impacts for generating ideas about significant concerns and possible alternatives. It is difficult to test and compare between projects since there are no common metrics.
2. Integrated quantitative risk assessment analysis	This approach employs the quantification of data to attempt to predict impacts based on a systematic analysis by applying and integrating methods from environmental health, toxicology, epidemiology, engineering and economics. These impacts can be measured in different ways such as number of prevented deaths, years of life gained or lost (YLL), quality-adjusted years of life gained (e.g. QALYs and DALYs), cost-effectiveness ratio [38-39].	Quantitative assessment	This method uses a systematic quantitative approach that can be tested and reproduced. It can use for legal defense; however, its assumptions and uncertainty in projections also make it vulnerable to legal challenge by competing experts. The quantitative methods can be quantified from applying simulation modeling. The assessment is highly time- and cost-intensive which restricts their widespread application. It is limitations for evaluating multiple outcomes.
3. Mixed method	This approach uses a hybrid of between two approaches- community based and integrated health risk assessment	Qualitative and quantitative assessment	This approach can be relatively quick and efficient when compared to the quantitative approach. Methods are usually standardized and also usually some requirement for stakeholder involvement. The assessments within this approach, while taking elements of the first two approaches, may not do either work well.

2.4 HIA Methodology and Procedures

HIA can be divided into five sequential phases: 1. Screening or scanning procedure to determine whether an HIA should be conducted or explored on health risk impacts; 2. Scoping to outline the specific focus criteria of the HIA and methodologies to be used; 3. Profiling and appraisal positive & negative impacts of the project. Health impact assessment is used to analyze relevant evidence in order to make qualitative and quantitative assessments of potential health impacts; 4. Report preparation to synthesize the results and communicate them to target audiences and stakeholders (e.g. policy-makers and stakeholders); 5. Monitoring & evaluation as identified scoping and profiling impacts (Figure 2.2).

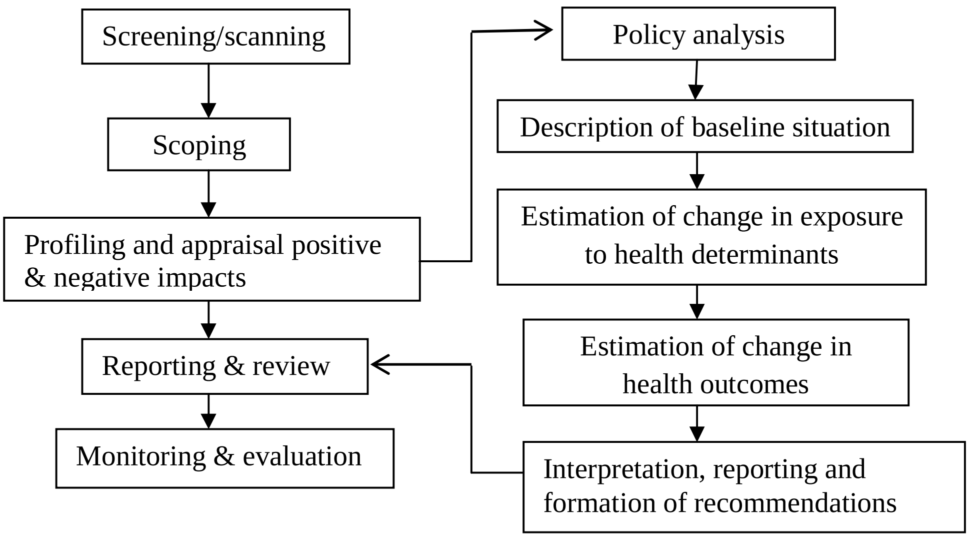


Figure 2.2: Schematic Overview of the HIA Procedure and Context

1. Scanning/Screening

Purpose and Analytical Steps

The main objective of this initial step is to assess the suitability or possibility of HIA for a proposal to conduct HIA according to policy and environmental involved contexts. It is also used to identify the significant health impacts through health determinant identifications. This might contribute valuable information to the political decision making.

The analytical procedures are included 1. Define the policy, program or project to be conducted and analyzed. According to HIA in EIA guidelines, a number of specific project/programs are required for conducting HIA. 2. The intensive review for criteria selection based on general HIA screening criteria guideline and relevant information for specific proposed program or project. 3. Determine the screening tool such as using checklist, screening guideline protocol, etc. 4. Review and make a primary assessment on whether to proceed with HIA with key stakeholders.

2. Scoping

Purpose and Analytical Steps

The specific objective of this stage is to outline the possible model or procedure that may cause health impacts based on health determinants and health-related outcomes, the proceeding approach and methodology as well as the required additional resources and challenges.

The intensive review and literature searches, expert consults, and stakeholder opinions are determined the policy approach, population affected, and health determinants and its impacts. The scope for impact analysis is included the baseline characteristics of target population to maximize the resource uses and its efficiency.

3. Profiling and Impact Appraisal

Purpose and Analytical Steps

The main purpose of this stage is to disseminate the key aspects of demographic and health status of affected population as well as to identify both positive and negative health impacts. The descriptive characteristics of area and community that are likely to be affected have been compiled such as socio-demographic and health data from health registry data and relevant key informants [35]. The health status and health baseline have been described for susceptible change that may act as anticipated health indicators. In addition, the vulnerable or disadvantage population is required special consideration. The qualitative and quantitative measurements are evaluated based on evidence that casual links with health outcomes and potential health effects.

4. Report preparation

Purpose and Analytical Steps

The main objective of this report is to summarize the descriptive basic information and synthesis the qualitative and quantitative findings. The study synopsis of findings is summarized and proposed for policy-makers and approval mechanisms.

5. Monitoring and Evaluation.

Purpose and Analytical Steps

The main stage is to follow up and evaluate the proposed project/program. The detailed information about project/program at different stages such as before, duration, and after implementation project have been monitored according to HIA protocol and impact appraisal indicators.

2.6 HIA Quantifications and Evaluation Methods

Evaluation of HIA effectiveness is important to demonstrate and facilitate the decision makings. There are three types of HIA evaluations including process evaluation, impact evaluation, and outcome evaluation. Process evaluation determines how the HIA process has been conducted. Impact evaluation assesses the effect on decisions made based on proposed procedure and guideline in both qualitative and quantitative methods. Outcome evaluation is employed to compare the health outcomes in different stages of implantation with initial stage evaluation phase or baseline [42]. Quantitative method has been used for certain HIA outcomes such as air pollution modeling for assessing level of dust exposure in respiratory health outcomes. The epidemiological techniques, for example, time series analysis, could be considered for HIA quantifications [41].

However, a number of HIA implementation procedures and quantitative assessment have been identified such as deficiencies in the evidence base, lack of capacity, and difficulty embedding HIA in political and organizational context.

Evaluation of epidemiological evidence for HIA

There are several steps that involve in quantification processes for epidemiological HIA assessment, including 1) specify the aim and framework of the impact assessment with clear and purposively, 2) specify the method used to quantify uncertainty, for example, provide the minimum or the maximum number of cases attributable to some hazards, 3) specify the measure of exposure and the range of exposure to be considered and the magnitude of the impact of a health hazard strongly depends on the level and range of exposure, 4) derive the population exposure distribution and specify the time window between exposure and effect, 5) select appropriate health outcome, for example, the burden of disease approaches like Disability-Adjusted-Life-Years (DALY) [48], where time spend in ill health and premature mortality are combined in a composite index, 6) estimate the exposure-response relationship in the population of interest, and 7) derive population baseline frequency measures for the relevant health outcomes and calculate the number of attributable cases. The improvement of epidemiological studies for HIA should provide adequate and complete information of the exposure used, including definition, measurements, exposure distribution and ranges of observed exposure. More emphasis should be placed in epidemiological research on the explicit assessment of no effect thresholds of exposure [47, 51].

A number of tools for health impact quantification have been developed using modeling through calculating assumption and computing power. HIAs can be conducted at varying degrees of detail, rigor and formality depending on needs and resources. Some of the tools are generic, while others have been tailored to deal with specific determinants or diseases only (Table 2.4).

Table 2.4: Overview of tools developed for quantitative health impact assessment

Model Tool	Characteristics of tool	Analysis design	Application
DYNAMO-HIA (Dynamic Modeling for Health Impact Assessment) [48]	A ready-to-use tool to project the effects of changes in risk factor exposure due to policy measures or interventions on disease-specific and summary measures of population health.	It is free and standalone. It models is a real life population, dynamic, and projects reference and intervention scenario over time, It has explicit risk factor states and handles mortality selection due to earlier mortality among those exposed to risk factors. It has a parameter estimation module reducing data needs. It provides rich output and has a graphical user interface that needs no programming or advanced computing skills, and allows general accessibility.	It is a partial microsimulation model that is used to generate individual risk factor histories, but not for generating disease histories. The probabilities of disease of each individual are calculated using deterministic methods. Both the simulation of risk factor histories and the calculation of disease probabilities are based on a Markov Model.
INTARESE/HEI MTSA (Integrated Assessment of Health Risks of Environmental Stressors in Europe/Health and Environment Integrated Methodology and Toolbox for Scenario Assessment) [49]	Platform with integrated set of standalone module and closely links models and datasets	The full chain approach tracks the environmental health effects of policies from how they affect emissions of pollutants (to air, soil and water) through changes in pollutant concentrations and associated changes in human exposure to health impacts, later aggregated as Disability Adjusted Life Years (DALYs).	It is commonly used for cases on climate change. It is applied via case studies of policies in various sectors (transport, housing, agriculture, water, chemicals, waste and climate) and an integrative case study on the environmental health effects of climate change policies, involving full chain analyses of key pollutants (outdoor air, indoor air, noise, pollutants with complex pathways) from how policies affect their emissions in different sectors through to aggregated health effects.
RIVM-CDM (Rijksinstituut voor Volksgezondheid en Milieu (RIVM) and Chronic Disease Model) [50]	A multi-state Markov model defined by multiple risk factor classes and disease stages can be approximated efficiently without modeling all combinations of risk factor and disease classes.	For a multi-state Markov model that describes the change of the joint probability distribution over all model states.	This model includes multiple states based on risk factor levels and disease stages but only keeps track of the marginal probability values.

Example of air pollutant quantification tool for health effects

Quantifying the effects of air pollutant exposure has become a critical component in policy discussion and making decision. The software tool AirQ has been developed by performing calculations that allow the quantification of the health effects of exposure to air pollution, including estimates of the life expectancy reduction. The calculation for estimation of the effects of short-term changes in air pollution based on risk estimates from time-series studies and the effects of long-term exposures using life-tables approach and based on risk estimates from cohort studies [52].

2.7 Health Risk Assessment for Cement Dust Exposures

Cement & Fiber Cement Processing and Work Environment

In Thailand, occupational injuries and diseases are one of the main burdens of diseases among Thai workers. There are 17.92 per 1,000 of workers who registered with the Workmen's Compensation Fund were diagnosed and reported of having occupational diseases or injuries in 2010 [45]. Preventing occupational accidents and injuries have benefits to not only employees and employers, but also reducing public health services and costs. These incidences are contributed to substantial loss in not only themselves and families. There also affect the community and society in general.

In Thailand, there are 3,873 establishments manufacturing related to cement tile, roofing materials, and related products with 69,300 employees (TIS code 57(1), 57(3), 58(1), and 67(3)) [46].

There are several processes in cement factory production, where airborne dust exposure among the workers is likely to be exposed. A review of cement studies has indicated that cement workers might be exposed to dust levels ranging 11–230 mg m^3 for total dust and 2–46 mg m^3 for respirable dust [8].

In working process and procedure in roofing fiber cement, there are 4 main processes for producing roofing cement materials. First, cement bag has been teased by bag opener. Next, mixing pulp and sodium bentonite have been poured into turbo mixer. Then, it has been mixed with mixing pulp followed by cement into rod mill. Second, the mixing ingredients have been weighted and rinse water into slurry by control density before sending to racking and curing. Third, the raw materials have been transformed into sheet through curing process. The sheet has been prepared pre- and post-cure coating & drying and then spray assigned color. Finally, the sheet has been stripped and inspected for quality checking and control. The final products are ready to collating and packaging and stored in the warehouse. The chemicals and airborne dusts that can be sampled and presented in work environment are including respirable and total dust, chromium (III) compound, iron oxide fume, hydrogen chloride, methyl ethyl ketone.

Respiratory health illnesses and symptoms among occupational cement exposure have been well documented and described. However, the results of adverse respiratory health through respiratory symptoms and ventilatory function are not entirely consistent. Such findings of airway function impairments and respiratory symptoms have been conducted mostly in epidemiological studies. The causal associations between cement dust exposure and pulmonary diseases and related diseases are conducted by epidemiologic and animal studies (Table 2.5) [8-19].

Table 2.5: The selected review study for dust exposure at cement industry, 2008-2011

Study authors, year, country	Sample size		Exposure index		Key findings	
	Exposed (n)	Unexposed (n)	Mean total dust mg/m^3	Mean respirable dust mg/m^3	Respiratory symptoms and illnesses	Pulmonary function test and outcomes
Nordby et al, 2011,EU	4,265					FEV1 OR = 1.2-2.6
Zeleke et al, 2010 & 2011, Ethiopia	127	91	48.8±31.9	N/A		FEV1, FEV1/FVC
Neghab & Choobineth, 2007,Iran	88	80	53.4±42.6	26.0±14.2	Cough, phlegm, wheezing, shortness of breath*	FVC, FEV1, FEF25-75%*
Mwaiselage J et al, 2004 & 2005,Tanzania	120 11.0±8.2 Yrs	107 14.8±8.2 yrs	13.1±10.1	1.5±2.1	Cough, chronic sputum production, phlegm, dyspnea, shortness of breath, bronchitis*	FVC, FEV1, FEV1/FVC, FEF25-75%* COPD*
Fell et al, 2003, Norway	119	50	N/A	N/A	Not sig.	Not sig.
Al-Neaimi et al, 2001,UAE	67	134	N/A	N/A	Cough, phlegm, dyspnea, sinusitis, bronchitis*	FVC, FEV1, FEV1/FVC*
Noor et al, 2000,Malaysia	62	70	0.192	N/A	Cough, phlegm, dyspnea shortness of breath	FEV1, FEF25-75%
Yang et al, 1996,Taiwan	591	N/A	N/A	N/A	Cough, phlegm, dyspnea shortness of breath	FVC, FEV1, FEF25-75%
Abrons et al, 1988,USA	2,736	755	2.90*	0.57*	Not sig.	Not sig.

*Geometric mean

CHAPTER III
METHODOLOGY

This study aimed to develop HIA tools for roofing fiber cement industry. This could be applied as an initiated model for other related factories in Thailand, especially in industries that are inclusively promulgation. This chapter describes the research methodology of the study. It includes overview of study phases and procedures according to 5 sequential HIA methods, data collection and data analyses and syntheses.

3.1 Research Design and Methods

According to a walk-though survey on health risk assessment and literature review, health determinants for roofing fiber cement industry can be classified into 7 categories [53]. Individual health determinants are determined according to age, gender, occupation and salary, education, and health behavior risks. Social determinants are involved, for example, work employment, work safety and security, and drug use and drug addiction. Health care providers and services include health care services and facilities, health care providers and specialists, and emergency and evacuation. Environmental health services are addressed on waste management, water supplies, and housing sanitation. Environmental issues are considered according to physical environment (noise, heat, dust, vibration, etc.), chemical environment (heavy metals, and organic and inorganic wastes, etc.), and biological environment (germs, bacteria, parasites, and animal vectors, etc.). Health status or health indicators are concerned including morbidity and mortality rate, estimated risk from project development, accidents and injuries, mental health, etc. Finally, health impact assessment is determined according to health risks and consequences (Table 3.1).

Table 3.1 Health determinants, methodology and data sources, and responsible organization involved for roofing fiber cement factory [53]

Health status and health determinants	Methodology and data source	Responsible organization and agency involved
1. Individual health determinants		
1.1 Age	21 folders of JHCIS [a]	Health Center/Hospital
1.2 Sex	21 folders of JHCIS	Health Center/Hospital
1.3 Occupation	21 folders of JHCIS	Health Center/Hospital
1.4 Salary	Basic minimum need Data	Department of Local Promotion
1.5 Education	Basic minimum need Data	Department of Local Promotion
1.6 Health risk behavior	Area survey	
▪ Diet		
▪ Health risk from pesticides, chemical uses, etc.		
▪ Sanitary and toilet using		
▪ Sleeping habits		
2. Social determinants		
2.1 Social involvement and participation	21 folders of JHCIS	Health Center/Hospital
2.2 Work employment	Basic minimum need Data	Department of Local Promotion
2.3 Safety and security	Basic minimum need Data	Department of Local Promotion
2.4 Drug use and drug addiction	Basic minimum need Data	Department of Local Promotion
3. Health care providers and services		
3.1 Health care services and facilities		Provincial Health Office
3.2 Number medical and health care providers		Provincial Health Office
3.3 Emergency and evacuation		Local manucipatory office
4. Environmental health services		
4.1 Waste management	21 folders of JHCIS	Health Center/Hospital
4.2 Water supplies	21 folders of JHCIS	Health Center/Hospital
4.3 Housing sanitation	21 folders of JHCIS	Health Center/Hospital
5. Environment		
5.1 Physical environment e.g., cement dust, noise, heat, vibration, etc.	Literature review, area survey and samplings	Cooperated local organization/internet/media
5.2 Chemical environment e.g., chromium compounds, hydrogen chloride, etc.	Literature review, area survey and samplings	Cooperated local organization/internet/media
6. Health status		
6.1 Morbidity rate	21 folders of JHCIS	Health Center/Hospital
6.2 Mortality rate from CD and Non-CD	21 folders of JHCIS	Health Center/Hospital
6.3 Estimated risk from project development	21 folders of JHCIS, health survey	Health Center/Hospital Department of Disease Control
6.4 Mental and spiritual health	Mental health report	Center of Mental Health
6.5 Accidents and injuries	21 folders of JHCIS	Health Center/Hospital
7. Health impacts	Literature review, area survey and samplings	Cooperated local organization/Internet/media

[a] JHCIS = the Java Health Center Information System

This study has been conducted into two-phase in both qualitative and quantitative methods, including Phase I: Developing tools and guideline for roofing cement industry and Phase II: Implementation and evaluation of HIA guideline. Initially, the intensive literature review regarding HIA for cement industry in both domestic and internationals was explored as well as the walk-through survey has been conducted. Appropriated approaches and recommended guidelines were evaluated and appraised. The literature searches were classified into 5 sequential steps (screening, scoping, appraisal, reporting and review, and monitoring and evaluation) according to health determinants. A questionnaire interviews has been conducted from HIA experts (Figure 1.1).

The in-depth interview for 8 key stakeholders was conducted according to 5 main steps as summarized followed the first phase. Health risk assessment has been conducted in both qualitative and quantitative methods. Finally, the data have been synthesized and summarized for HIA tools for the roofing fiber cement industry.

This study is designed and integrated different aspects of epidemiological study, qualitative and quantitative analysis methods. The descriptive analysis is purposively to assess health impact into four dimensions, including physical, psychological, social, and spiritual aspects. The qualitative assessments were developed based on health consequence rating and health risk matrix. The quantitative method will be assessed through hazardous risk assessment. The HIA tools were developed and implemented for testing and evaluating the capacity according to five sequential steps (Table 3.2).

Table 3.2: Developing the HIA tools for roofing cement industry

Phase/Stage	**Main Objective**
1.Screening	To determine whether an HIA should be conducted
2. Scoping	To outline the specific focus of the HIA and methodologies to be used
4. Appraisal (profiling impact assessment)	To disseminate the data and analyze relevant evidence in order to make qualitative and quantitative assessments of potential health impacts
4. Report and review	To synthesize the results and communicate them to involved populations.
5.Monitroing and evaluation	To follow up and evaluate the proposed project/program

3.2 Study Techniques and Study Procedures

This study was employed in both qualitative and quantitative methods (Table 3.3). The descriptive study was characterized as the followings:

1. The descriptive epidemiological study of populations and employees at the roofing fiber cement factory using health data registries under Java Health Center Information System(JHCIS program) from Ban Klongsoa and Ban Kaewsaen Health Center between 2008 and 2011 (3-year data).

2. Quantitative study was conducted questionnaire interviews, personal and environmental samplings among populations and employees who have recorded related to respiratory health diseases from JHCIS database.

3. Qualitative study was conducted through questionnaire interviews of HIA experts and key stakeholders. The HIA experts were consisted of academic experts in safety engineering, occupational health and safety, and HIA experts from public agencies and private industry. The key stakeholders were consisted of community leaders, health volunteers, employee representatives, the factory administrator, etc.

Table 3.3: Study procedures and study methods for developing the HIA tools for roofing cement industry

Study methods	**Study subjects**
Qualitative Methods	
A walk-through survey	Observation, checklist, and existing data reviews
Questionnaire interview (n=5)	Professors and HIA experts from Universities HIA experts from MONRE [a] HIA expert from MOPH [b] HIA expert from private industry
In-depth interview key stakeholders (n=8)	Factory manager Community leader Public Health Officer Employee Nearby population
Quantitative Methods	
Respiratory health questionnaire interview and physical health exams (n= 341)	Employees Affected populations (living nearby the factory)
Health impact assessment screening for health determinants (physical, psychological, social, and spiritual aspects)	Populations who are living within 2 km and 5 km in radius from the factory
Health risk assessment (HRA)	Spirometry measurements (employees and populations) Personal and environmental samplings Health statistics from JHCIS (3-year data)

[a] MONRE = Ministry of Natural Resources and Environment
[b] MOPH = Ministry of Public Health

Descriptive Characteristics of Study Populations and Samples

At the cement factory is located, there were totally 6,746 populations (male = 3,220; female=3,376). The health data registries were endorsed from two assigned Health Centers. According to Kongsoa Health Center (KHC), there were totally 2,140 populations who are living nearby the factory within 2-km in radius whereas 4,606 populations who are living far (Kaewsaen Health Center; KSC) from the factory at 5-km in radius.

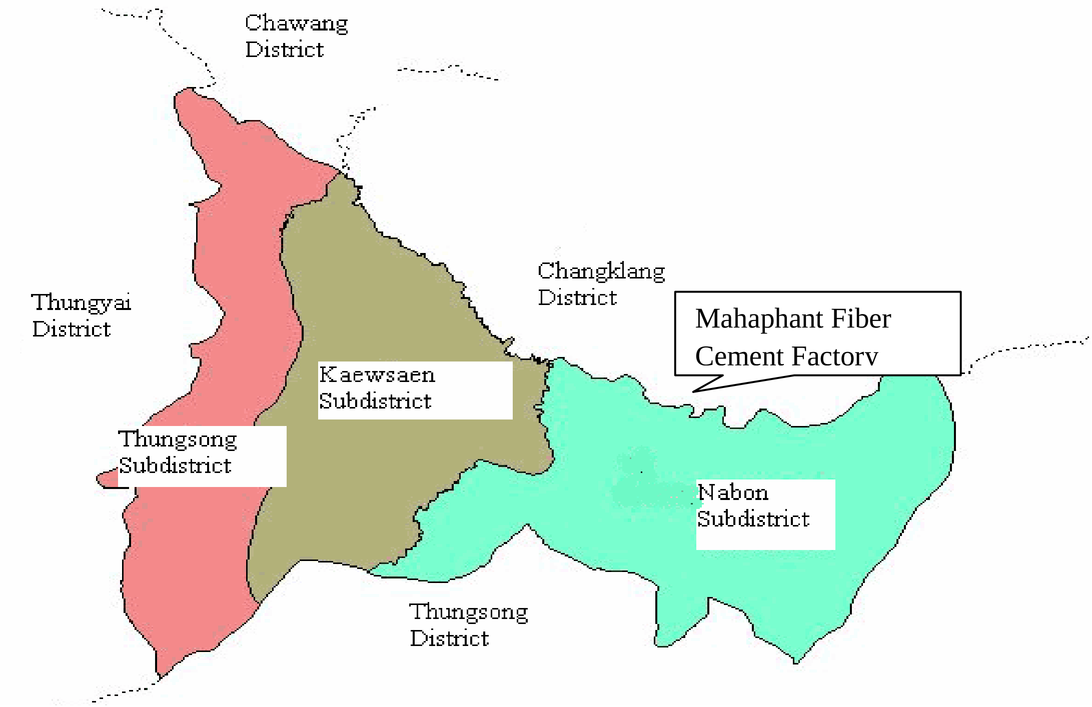


Figure 3.1 Map of Naborn District

Company Profile

The roofing fiber cement factory where this study was conducted was established in 1974 and is located in Naborn Sub-district, Naborn District, Nakhon Si Thammarat. The factory covers an area of 180,000 square meters. Its buildings cover 34,000 square meters. A total number of 202 workers are employed in the factory (male = 187, female = 15). Roofing boards are the main production of the factory. The factory produces 9,000 tons of boards and related products in each year (Figure 3.2-3.3).

Figure 3.2 Map of the roofing cement factory
(Photo courtesy of Mahaphant Fiber-Cement Public Co., Ltd.)

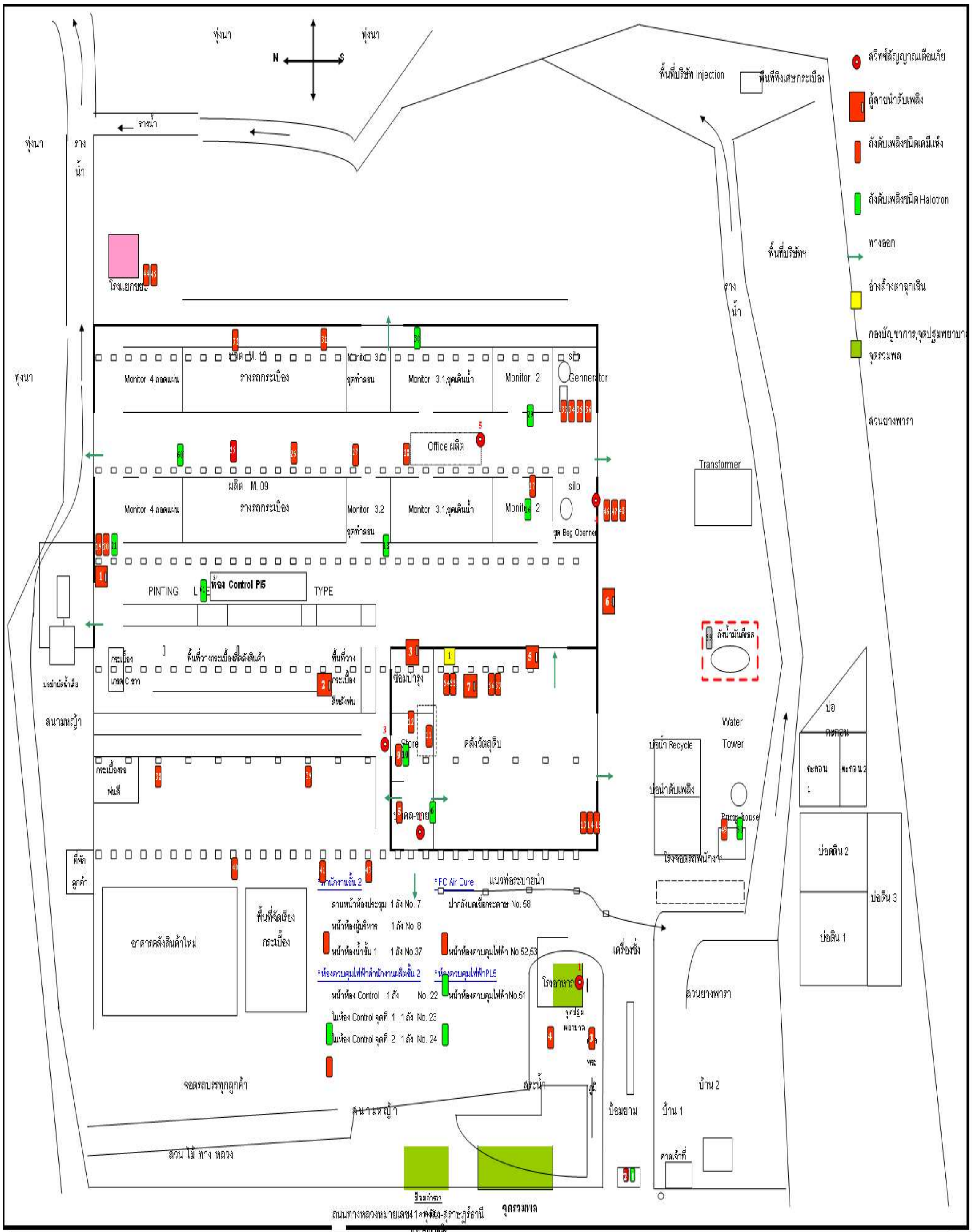


Figure 3.3 Layout of the roofing cement factory
(Photo courtesy of Mahaphant Fiber-Cement Public Co., Ltd.)

3.3 Study Aims and Data Collection

The data collection has been disseminated according to the study specific aims. The study descriptive and characteristics were summarized according to study phases and procedures. The details of each specific aim have been presented in Chapter 4.

Phase I: Developing Tools and Guidelines

This study phase was intensively review of experienced using the HIA protocol and procedure in both domestic and internationals and assess for applicability for cement factory in Thailand. The literature review was critical appraisal addressed HIA protocols. A literature search was conducted on Google Search, Medline, and website of related public organizations and agencies in Thailand. The details of HIA activities and reports were obtained from published literatures and websites as well as the further communication with the primary authors. Using multiple search strategies, selected HIA projects were identified that have been completed in Thailand during 2000 –2011. Key feature characteristics and details of each HIA were abstracted from published and unpublished sources (Table 3.4).

Specific Objective 1: Review the HIA into environmental health assessment (EIA), existing legal requirements of health risk analyses, and the lessons –learned for integrating HIA within EIA process in Thailand.

Table 3.4: Study review approaches, procedures, and objectives for HIA in EIA

HIA Approaches	Objectives	Procedures
1. Scanning/ Screening	To assess the suitability of HIA for a given policy proposal in order to decide whether or not to proceed with the HIA and in what aspects in roofing fiber cement factory. The purpose of scanning is to identify current or emerging policy proposals for which an HIA might produce useful information.	1. Define HIA in EIA policy, program or project related to cement factory to be analyzed. 2. Review criteria for selection (including general HIA screening criteria and additional criteria relevant to a particular cement factory, local, etc). 3. Complete and discuss screening tools (checklists, etc.) 4. Make a preliminary assessment on whether to proceed with HIA. 5. Review decision with key stakeholders.
2. Scoping	To outline the impacts, an explicit model describing how the proposed policy may impact health determinants and health-related outcomes, methodological approach, expected challenges and resources needs for impact analysis.	1. Consult policy-makers, stakeholders, experts and research literature to assess and describe the proposed policy, population affected, immediate, intended effects, health-related secondary and side effects, and pathways through which the proposed policy or program is expected to affect health outcomes and intermediate outcomes (i.e. determinants of health). 2. Determine methodologies to be used and set boundaries for the proposed HIA to maximize the efficient use of resources for producing the most salient and valuable information.
3. Profiling	To describe key aspects of the health status and demographics of the population that can act as a baseline against which possible health impacts can be assessed.	1. Compile a profile of the areas and communities likely to be affected by the cement factory using available socio-demographic and health data registries based on JHCIS of Health Center and information from key informants. 2. Describe key aspects of the health status and general make-up of the population nearby the factory and employees at the factory, particularly in relation to factors that are believed to be susceptible to change or that may act as indicators of anticipated health impact. In this study, we will focus on chronic respiratory outcomes. 3. Assess the nature and characteristics of occupational exposure group whose health could be enhanced or placed at risk by the cement factory efforts.

Table 3.4: Study review approaches, procedures, and objectives for HIA in EIA (cont.)

HIA Approaches	**Objectives**	**Procedures**
4. Impact assessment	To identify the positive and negative health impacts of the cement factory to in its employees and community. There are three main dimensions, including psychological, social, and spiritual aspects.	1. Assess qualitative evidence pertaining to each of the links in the causal chains linking the policy with putative respiratory health outcomes using structure interviews. 2. Assess quantitative assessment through questionnaire interviews, health examination, spirometry test, and airborne dust samplings. 3. Conduct medical cost utilization analyses from data of health center registries when feasible and appropriate.
5. Report preparation	To produce a coherent, usable synthesis of findings from the analysis.	1. Document the quantitative and qualitative findings from the analytical steps of the HIA 2. Prepare a summary of the findings for policy-makers and key stakeholders.

This study was conducted questionnaire interviews with HIA experts. The main objective of this study was to assess the draft of HIA tools for applying at roofing fiber cement factory and community nearby using questionnaire interviews. This method was used for structuring HIA experts and a key stakeholder communication process. Furthermore, it was used for the systematic solicitation and collation of judgments on a particular HIA tool through a set of carefully designed sequential questionnaires interspersed with summarized information and feedback of opinions derived from their responses. The questionnaire interviews were carried out and analyzed. The final review HIA tools were incorporated and revised. The final draft was described and proposed for HIA tools for roofing fiber cement factory.

Phase II: Implementations and Evaluation

Synopsis and overview of this phase was conducted implementation and evaluation the HIA tools through project testing at the roofing fiber cement factory and proximity community at Naborn Sub-district in qualitative and quantitative measurements for quantifying the occupational exposure risks in the factory, particularly health hazards.

The main objective of this aim was to implement and evaluate how the HIA tools were appropriate for using as a procedure for HIA in a roofing fiber cement factory and community. The initial step for this process was incorporate necessary data including basic background information of the factory, process and manufacturing procedure, and community involvement. The key stakeholders were identified, including factory owners, factory management team, employee representatives, community leaders, healthcare workers, and other concerns. The address concerns were discussed based on brain storming. The dialogues were determined focusing on health risks in working procedures, chemical uses, and the environmental impacts in both in factory and community nearby.

The second step was to profile and scope necessary messages from initial step. The defining the scope of relevant HIA for fiber cement industry was identified. The factory HIA analysis was coverage normal operation, airborne dust, hazardous chemical uses and characterizations. The environmental monitoring were airborne dust monitoring in both personal and area samplings. Community involvements included anthropogenic changes and effects. The target population and involvement were consisted of distribution by age, sex, etc., health status based on health reports, disease registries, behavior patterns, activities, and hobbies.

The third step was appraised based on both positive and negative aspects. The four main elements include physical, psychological, social, and spiritual aspects. In each aspect, the evaluation criteria were assessed as yes and no (positive answer; yes = 1, no =0; negative answer; yes =0; no =1). For each particular hazard, an estimate was made of the number of people exposed to particular levels and the likelihood of an individual experiencing harm when exposed to those levels. It was then a matter to calculate the numbers of individuals who would be expected to experience particular harms.

The HIA tools assessment were determined through occupational & environmental risks. A cross-sectional study was conducted for assessing environmental and occupational risk factors to airborne dust exposure. The data analysis was consisted of the relations between risk factors (age, height, gender, job title, duration of exposure, etc.) and the health effects of occupational exposure to airborne dusts (pulmonary function defects and respiratory symptoms).

Specific Objective 2: Examine occupational dust exposure levels and the health risk hazards in the roofing fiber cement processing industry in the South of Thailand.

A cross-sectional study was conducted at the fiber roofing cement factory in the South of Thailand. In working process and procedure of the roofing fiber cement factory, there are six main processes for producing roofing fiber cement materials, including mixing and pulping, racking and curing, de-palleting and skid, quality control and painting and spraying injection, and inspection and storage. According to preliminary conducted walk-through survey, workers did not use or consistent use personal protective equipment such masks protection. Most of the workers changed their jobs and did not hold the same job title for long period of time. The records of physical exams and environmental samplings were also reviewed.

Specific Objective 3: Assess self-HRA of populations with living proximity.

A cross-section study has been conducted between July and September 2011 among populations who are living nearby the roofing cement factory.

At the cement factory is located, there were totally 6,746 populations (male = 3,220; female=3,376). The health data registries were endorsed from two assigned Health Centers. According to Kongsoa Health Center (KHC), there were totally 2,140 populations who are living nearby the factory within 2-km in radius whereas 4,606 populations who are living far (Kaewsaen Health Center; KSC) from the factory at 5-km in radius.

The descriptive characteristic data for assigned populations were extracted from the Java Health Center Information System (JHCIS) of KHC and KSC. This program has been recorded since 2009. The registered data have been recorded according to basic data classified into 18 family folders. A sample size of 96 participants living within 2-km and 101 participants living farther at least 5-km in radius from the roofing fiber cement factory was participated and completely interviewed in this study.

Specific Objective 4: Examine the associations between respiratory symptoms and patterns of pulmonary dysfunction among roofing fiber cement employees.

Subject Recruitment:

There are 341 participants that were recruited in this study. This study recruited employees in total 110 workers from cement factory in Naborn District, Nakhon Si Thammarat Province. The recruitment included asking permission for participation in this study from all workers and their employers to administer questionnaire interview, lung function test, and personal and area samplings. Similar to employees, 110 populations nearby the factory were also invited to participate in this study and conducted questionnaire interviews and lung function test. It was also 110 populations who are living at far from the factory whose were recruited as a reference or low exposure group (Figure 3.4-3.5).

Sample Calculation

The targeted population this study was approximately 110 workers at fiber-cement factory of Mahaphant Fiber-Cement Public Co., Ltd. in Nakhon Si Thammarat Province. Detection of the difference between two population proportions is calculated as follows :

$$n' = \frac{\left(z_{\alpha/2}\sqrt{2\overline{P}\overline{Q}} + z_{1-\beta}\sqrt{P_1Q_1 + P_2Q_2}\right)^2}{\left(P_2 - P_1\right)^2}$$

$$n = \frac{n'}{4}\left(1 + \sqrt{1 + \frac{4}{n' / P_2 - P_1 /}}\right)^2$$

Definitions:

n' = A sample without continuity correction
n = A sample with continuity correction
P_1 = Proportion or prevalence rate of respiratory symptoms among cement dust exposure (17%) [Neghab et al , 2007]
P_2 = Proportion or prevalence rate of respiratory symptoms among non-cement dust exposure (5 %) [Neghab et al , 2007]
α = 5%
1-β = 80% (power)
$Q_1 = 1-P_1$, $Q_2 = 1-P_2$, $\overline{P} = (|P_1-P_2|)/2$, $\overline{Q} = 1- \overline{P}$

There were at least 106 subjects required in each group with continuity correction. However, this study recruited 110 subjects for each group.

Inclusion and Exclusion criteria

For employees, workers who are over 20 years old, having worked at least one year at this factory. The workers with previously diagnosed as asthma, tuberculosis, and respiratory symptoms are also included. The previously diagnosed as asthma, tuberculosis, and respiratory symptoms will be reviewed from medical history and treatment of the workers who report that they have experienced. For populations who live nearby the factory (less than 2 kms from the factory), they are over 20 years old and who are not working in the cement factory and live in Moo 1,2 of Naborn Subdistrict. For populations who live at far from the factory (more than 5 kms from the factory), they are over 20 years old and who are not working in the cement factory and live in Moo 7,8 of Naborn Subdistrict. The last two groups of study populations in the community are recruited similar criteria as the employees.

Sample Selection

One hundred and ten workers were interviewed and had personal sampling and their lung function tested. From previous a walk-through survey, there were eight main groups of workers who were working in different stations and job classification.

This study classified group of workers by different types of tasks or job specifications as homogenous exposure group (HEGs) or similar exposure group (SEGs). A full shift of airborne dust exposure was performed. In addition, twenty area samplings were conducted in different areas of the factory.

Figure 3.4 Questionnaire interviews

Figure 3.5 Spirometry measurements

Pulmonary function test (Spirometry Measurement)

Spirometry is the most commonly used lung function screening study. It is used to evaluate symptoms, for example, chest pain, cough, dyspnea, orthopnea, phlegm production, and wheezing. It is also employed for evaluating signs of chest deforminity, cyanosis, diminished breath sounds, expiratory slowing, overinflation and evaluating abnormal laboratory tests such as abnormal chest radiographs, hypoxemia, and hypercapnia.

Specific Objective 5: Develop the HIA guideline practice for the fiber cement factory industry.

This study disseminated findings on occupational exposure risk impact assessment and HIA tools for determining the applicability to use in roofing fiber cement industry. The main objective of this stage was to evaluate the findings from implementing and assessing the HIA tools for applying at roofing fiber cement industry. The questionnaire interviews and the health risk assessment were analyzed. The final draft and findings were disseminate and proposed for HIA tools for roofing fiber cement industry.

3.4 Data Management and Analysis

Specific Objective 1: Review the HIA into environmental health assessment (EIA), existing legal requirements of health risk analyses, and the lessons –learned for integrating HIA within EIA process in Thailand.

The literature review for HIA in cement industry has been summarized and analyzed. A brief descriptive of preliminary assessment on the feasibility and value of an HIA was identified and determined. An outline for the impact analysis was included data on the relevant baseline characteristics of the target population. A comprehensive description of the socio-demographic and health profile of a community or population surrounded the factory was described. A brief summary and assessment of literature, expert opinions, for example, and impact estimates, including probable direction, magnitude, distribution and likelihood were evaluated and described. A comprehensive HIA report for target audiences (e.g. policy-makers and key stakeholders) was presented. The report was included a brief summary as well as a more complete report that provided detailed information about the findings, methodologies, and underlying assumptions (Table 3.5).

Table 3.5: Study procedure and analytical steps

Procedures	Analytical Steps
Screening	
1. Define the HIA in EIA policy, program or project related to cement factory to be analyzed	-Reviewing the HIA in EIA policy and programs related to cement factory from domestic and internationals through searching database and tools-Pubmed, Thai National Research Repository, etc. -Comparing the HIA policy between Thailand and internationals.
2. Review criteria for selection	The reviewing criteria including general HIA screening criteria and additional criteria relevant to a particular program, local, etc.
3. Complete and discuss screening tools	Using checklist format
4. Make a preliminary assessment on whether to proceed with HIA	Evaluating the screening assessment
5. Review decision with stakeholders	Analyzing the draft of screening
Scoping	
1. Consult policy-makers, stakeholders, experts and community representatives	-Literature reviewing to assess and describe the proposed policy, population affected, immediate, intended effects -Evaluating health-related secondary and side effects, and pathways through which the proposed policy or program is expected to affect health outcomes and intermediate outcomes
2. Determine methodologies to be used and set boundaries for the proposed HIA to maximize the efficient use of resources for producing the most salient and valuable information.	-Evaluating HIA practical approach appropriate to Thai context
Profiling and data collecting	
1. Compile a profile of the areas and communities likely to be affected by the cement factory	Using available socio-demographic and health data and information from key informants.
2. Describe key aspects of the health status and general make-up of the populations	Analyzing key aspects of the health status and general make-up of the population, particularly in relation to factors that are believed to be susceptible to change or that may act a as indicators of anticipated health impact. In this study is focused on airborne dust exposure
3. Assess the nature and characteristics of occupational exposure groups and vulnerable populations in the community	-Evaluating characteristics of occupational exposure group and vulnerable populations in the community whose health could be enhanced or placed at risks. -Critiquing vulnerable and disadvantaged groups require special consideration.
Impact assessment	
1. Assess qualitative and quantitative evidence pertaining to each of the links in the causal chains linking the policy with putative health outcomes.	-Using health consequence rating -Using health risk rating -Using evidence from the literature to estimate potential health effects and their likelihood
2. Conduct cost analyses when feasible and appropriate.	Analyzing costs of workplace illnesses and injuries according through workmen compensation claims
Reporting	
1. Document the quantitative and qualitative findings from the preceding steps of the HIA	Analyzing quantitative and qualitative findings
2. Prepare a summary of the findings for policy-makers and key stakeholders.	Preparing a summary of the findings for policy-makers and key stakeholders

Specific Objective 2: Examine occupational dust exposure levels and the health risk hazards in the roofing fiber cement processing industry in the South of Thailand.

A total of 61 respirable dust and 66 total dust measurements were conducted for randomly selected workers from 10 occupational groups. Total dust was conducted using tared 5-µm filter with closed faced 37-mm Millipore samplers (NIOSH method 0500) whereas respirable dust using 5- PVC membrane with aluminum cyclone (NIOSH method 0600) [30] . Totally 5 respirable dust and 3 total dust samples were removed during the analyses since there were unexpected pump stop or not well sampling management and procedure. The arithmetic mean of respirable dust concentrations with each of occupational group was used in the calculation of the cumulative respirable dust exposure. The cumulative respirable dust exposure for representative workers was calculated as the sum of the products of arithmetic mean of respirable dust concentration and the years worked in the working areas, expressed as mg/m^3-years.

Specific Objective 3: Assess HRA of populations with living proximity.

The score for each question has been coded (positive statement; yes (1); no (0) and negative statement; yes (0); no (1)). The evaluative criteria for health impact have been calculated in percentage (positive impact (score 67-100%), between positive and negative (score 34-66%), and negative impact (score 0-33%), respectively. The chi-square was used to detect differences in the frequencies of categorical characteristics such as age, sex, education, and occupation between the groups. An independent t-test was used to analyze when analyzing difference in means between group of exposure and control group. A p-value of less than 0.05 was considered statically significant.

Specific Objective 4: Examine the associations between respiratory symptoms and patterns of pulmonary dysfunction among roofing fiber cement employees.

Pulmonary function measurements (spirometry) of exposed workers were conducted at the roofing fiber cement factory and explored the possible association between airborne dust exposure and pulmonary function defects and respiratory symptoms (Figure 3.6).

The descriptive data were presented for demographic data, pulmonary function defects and respiratory symptoms including FEV, FEV1, FEV1/FVC, and respiratory symptoms using STATA version 10 (StataCorp. College Station, TX, USA). Subjects were grouped into four patterns of pulmonary function: normal, FVC > 80% predicted and $FEV_1/FVC \geq 70\%$; obstruction, FVC > 80% and $FEV_1/FVC < 70\%$; restriction, FVC $\leq$ 80% and $FEV_1/FVC \geq 70\%$; and mixed (obstruction with air trapping or coexistent restriction), FVC $\leq$ 80% predicted and a $FEV_1/FVC < 70\%$. The risk factor analysis was used a chi-square test for different aspects of pulmonary function defects and respiratory outcomes. The confounding factor such as cigarette smoking was controlled.

The correlations between pulmonary defects and respiratory outcomes and pulmonary function test by adjusting age, gender, height, and smoking were used linear regression analysis at p-value< 0.05. Multivariate correlations between airborne dust exposure levels and lung function were tested by multiple logistic regressions.

Conceptual Framework

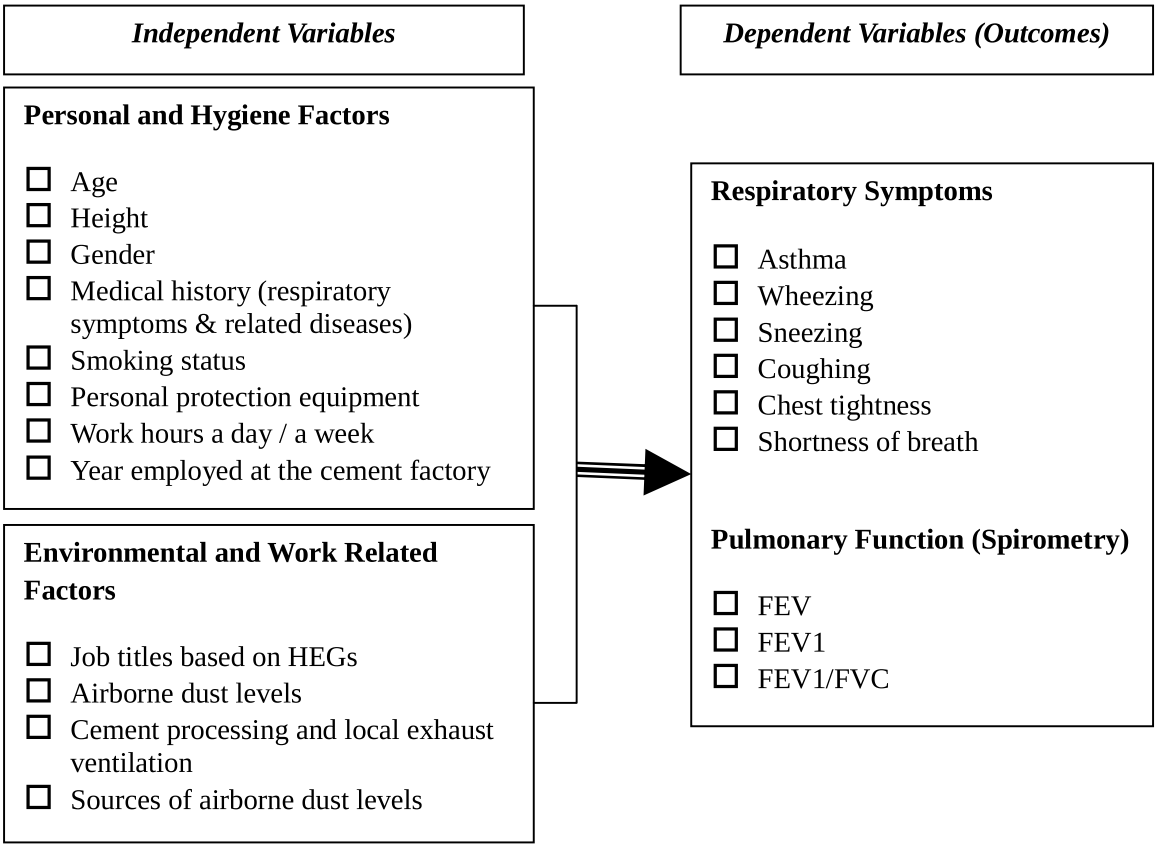


Figure 3.6: Conceptual framework of quantitative respiratory health risk assessment

Specific Objective 5: Develop the HIA guideline practice for the fiber cement factory industry.

After implementation and assessment the HIA, as well as the questionnaire interviews among different stakeholder groups, the findings were presented to key stakeholders, including employers, employees, and community. The oral presentation and report were summarized and pointed out the current status of the factory on HIA.

CHAPTER IV
RESULTS

The key findings of this study have been disseminated in both qualitative and quantitative methods. The outline of the results has been presented following the conceptual framework of the study. The results have been presented in the order of specific aims and the manuscript publications, including 1) Integrating Human Health into Environmental Impact Assessment: An Update Review of Health Impact Assessment from Thailand Experiences, 2) Determining occupational health risks and hazards at roofing cement processing factory, 3) Application of Self-Health Risk Assessment with Health Impact Assessment Toolkit: A Case Study of Cement Factory in the South of Thailand, 4) Respiratory Symptoms and Patterns of Pulmonary Dysfunction among Roofing Fiber Cement Workers in the South of Thailand, 5) Developing Health Impact Assessment Tools in the Roofing Fiber Cement Factory in the South of Thailand.

The results have been presented according the conceptual framework of the study (Chapter I) and followed in each specific aim. In first phase, the literature reviews in both Thailand and international experiences on HIA were introduced. The draft of HIA tools for roofing cement industry have been proposed based on domains health determinants, social and socioeconomic impacts, and health care facilities and services. The HIA protocols were included initial step, screening, scoping, appraisal, reporting and reviews, and monitoring and evaluation. In second phase, the assessment of the HIA tools through key informant questionnaire interviews with HIA experts were conducted as well as implementing and evaluating the HIA tools through pilot testing in fiber cement factory also conducted in both qualitative and quantitative measurements for quantifying the occupational exposure risks in the factory and community nearby, particularly health hazards. Finally, the key findings have been disseminated and recommendations for future studies on occupational exposure risk impact assessment and HIA tools for determining the applicability to use in cement factory.

The Developing Tools and Guideline for Roofing Fiber Cement Industry (Phase I)

***Section 1**: Integrating Human Health into Environmental Impact Assessment: An Update Review of Health Impact Assessment from Thailand Experiences*

This study employed the data from literature review according to five- step HIA standard procedure, including screening, scoping, appraisal, reporting and review, and monitoring and evaluation as input data for developing first draft for roofing fiber cement factory. The key domains in health determinants were considered according to environmental impacts, social and socioeconomic impacts, and health care services and utilizations. A literature search and reviews have been disseminated and summarized.

Introduction

The movement and attempts to integrate health impact assessment (HIA) into environmental impact assessment (EIA) or HEIA has been gradually progress in Thailand for the past decade. The strong fundamental supports of the Thai Constitution and the Thai National Health Act in 2007 played a crucial role for addressing on environmental quality and the health risk aspects of the Thai citizen [2,54-55]. The Ministry of Public Health (MOPH) has been leading for healthy public policy and health promotion, for example, HIA division of the MOPH are involved in undertaking HIAs and supporting technical approaches across sectors in both local and national levels since 2002[3]. The Ministry of Natural Resource and Environment (MONRE) is responsible for legislation process in which similar to developed countries like Canada, Australia, and New Zealand [4].

In Thailand HIAs can be undertaken for different stages or levels, for example, HIA may be conducted on the proposal for project, national, or even international levels such as Chatree mining project, Mab Ta Phut industrial estate expansion, and the Thai-China-Free trade agreement in produces supply chains [43,55-56]. All these HIAs have been increasing awareness and raised concerns among affected populations on health issues according to health determinants, including the social, environmental, cultural and political influences on population health [26,39,44]. Therefore, HIA can assess and add value to strategic policy and planning decision-making processes for project or program operation approval process.

The environmental protection on human health has been enacted in the Thai's modern law since 1992. The most important law are included the Enhancement and Conservation of National Environmental Quality Act 1992, Factory Act 1992, Public Health Act 1992, Hazardous Materials Act 1992, and Enhancement of Energy conservation Act 1992. In Thailand recently, EIAs have been required for assessment in 34 project types, including most public infrastructure projects (dams, power plants, waste plants, public transit, etc.), mining, chemical, oil and gas operations, metal works, cement production, pulp processing, and sugar processing [4].

This paper aimed to review recent status of HEIA and the requirement of enacted law according to the MONRE. Then the authors discuss the HIA practice and integrating into EIA, existing legal requirements of health risk analyses, and the lessons –learned for integrating HIA within EIA process. Finally, the authors discuss lessons learned from the country experiences and the role for public health in shaping the policies and decisions made using HIA.

Methods

A literature search was conducted on Google Search, Medline, and website of related public organizations and agencies in Thailand. The details of HIA activities and reports were obtained from published literatures and websites as well as the further communication with the primary authors. Using multiple search strategies, selected HIA projects were identified that have been completed in Thailand during 2000 –2011. Key feature characteristics and details of each HIA were abstracted from published and

Results

HIA in EIA Requirements, Policy and Process

In Thailand, EIA process has been endorsed far back since 1981. It has been used as a tool for environmental planning and management on the project development for screening approach. Under the Enhancement and Conservation of National Environmental Quality Act 1992, the MONRE has promulgated the type and size of projects or activities requiring EIA. The EIA report has been prepared for full consideration for the projects which will cause significant impacts on environment and human health. Legislating that potentially affected communities have the right to request discrete HIAs is conducted on proposal and to be involved in the HIA process according to the Thai National Health Act in 2007. The HIA in EIA process requires more intensive in public hearings and independent assessment. In addition, it must consider other existing environmental protection laws such as the Factory Act, 1992 and the Hazardous Substances Act, 1992.

The HEIA requires the report for the project or activity which may seriously affect community in changing in condition and utilization of natural resources, production, transportation and storage of hazardous substance, and discharge of waste and health threatening substance from construction and production process. In EIA report, it requires a technical assessment based on environmental impact assessment and monitoring methods. It should provide recommendations for prevention and protection the impact to environment and natural resources [4].

Integrated HIA in EIA: Examples and Practice

The HIA has been promulgated as a part of EIA process, by focusing on mega projects that may impacts on environment and human health under an approval mechanism. The overview of HIAs development in Thailand has been characterized [4-5], including 1) HIA in EIA (general guidelines for specific industries covering 34 types of business and industries), 2) HIA for healthy public policy (health promotion for disabilities and under represents), 3) HIA for local organizations and communities (agricultural chemical use, water management and irrigation, waste management, etc.), 4) HIA for legal regulations (Constitution of Thailand, 2007 in article 67, The National Health Act, 2007 in article 11 and 25), and 5) HIA for National Assembly and HIA collaboration and networks(Table 4.1).

Table 4.1: An Overview of HIA System Development in Thailand

HIA Feature and Characteristics	**Descriptive Focal Points**	**Example Projects**	**HIA Core Key Partners**
HIA in EIA	General HIA guideline	-HIA guideline for specific industries	-Office of Natural Resources and Environmental Policy and Planning, MONRE -Department of Disease Control, MOPH
HIA for healthy public policy	Health policy involvement	-HIA for health promotion for disabilities -HIA for Thai-China-Free trade agreement in produces supply chains	-Health Public Policy Foundation -Policy stakeholders
HIA for local administrations and communities	Community health impact assessment	-HIA for agricultural chemical use -HIA for water management and irrigation -HIA for waste management	-Department of Health, MOPH -Selected local governments
HIA for legal mechanism and enforcement	HIA in Constitution of Thailand, 2007 (Article 67)	-HIA in National Health Act, 2007 (Article 11 & 25)	
HIA in National Health Assembly	Supporting projects	-Mab ta phut industrial estate -Suvanabhumi airport	-National Health Commission -WHO
HIA collaborating network	National & international levels	-Educational training and capacity building -HIA in Southeast Asian Countries -HIA conference	-Higher institutes and universities -HPP academicians and researchers

The descriptive features of HIAs have been completed and ongoing projects in Thailand up until 2011 summarized in Table 4.2. The HIAs were conducted into environmental impact assessment (EIA) in Thailand (n= 5,447) [14]. It should be noted that only 2,220 projects (40.55%) have been conducted after the HIA in EIA has been promulgated in The Thai Constitution Act in 2007. In summary, the types of projects include community services and housings (n= 2,779; 51.02%), mineral and mines (n=1,168; 21.44%), industries (n= 592; 10.87%), petrochemical industries (n= 375; 6.88%), energy and power plants (n= 352; 6.46%), urban and transportations (n= 171; 3.14%) and water resource management and related projects (n= 10; 0.18%), respectively.

Table 4.2: Type of Project Submitted EIA Report, 1984-2011

Type of Project*	**Example of Project**	**No.**	**Percent**
1. Community services and housing	Housing, condominiums, hospitals and hotels	2,779	51.02
2. Mineral and mines	Cement factories, gold and cold mining	1,168	21.44
3. Industries	Pulping industries, steel and aluminum industries	592	10.87
4. Petrochemical industries	Petroleum production, polyethylene and plastic industries	375	6.88
5. Energy and power plants	Biomass and biogas power plants	352	6.46
6. Urban and transportations	Seaports, bridges, airports and railways	171	3.14
7. Water resource management and related projects	Irrigation systems and dams and waste water treatment plants	10	0.18
	Total	5,447	100.00

* The HEIA report has been promulgated in the Thai Constitution Act since 2007

According to promulgation of the MONRE as a legal mechanism for HEIA, there are four main elements for integrating human health into EIA, including physical environment, biological environment, natural resource utilization, and quality of life. A number of projects are not only been positive, but also have negative impacts on human health. Many environmental, social, and health problems have been reported and raised awareness and concerns. There are various forms of pollution, natural resources degradation, and social impacts affecting qualitative and quantitative of health burden such as Mab Ta Phut industrial estate expansion and Kwaenoi dam project (Table 4.3).

However, the HEIA is still uncompleted and fails to cover important aspects. The progress in developing HIA in the EIA guideline has been proposed in 2007. The approach for assessing HEIA is included principles for HIA conducting, scope of the study, health risk assessment, risk management and risk mitigation, and monitoring health impacts. In cooperating with the Department of Disease Control and Department of Health of MOPH, the guidelines have been more detailed on health impacts, methods for assessing risks, and a procedure for assessing health impacts. The integrated database on HIA has been enhanced for HEIA. In addition, capacity building and networking are also important for enhancing HEIA.

Table 4.3: Exampled of key selected features of HIAs at Mab Ta Phut industrial estate expansion project and Kwaenoi dam, 2000-2003.

Methods and procedures	**Scoping: health determinants affected**	**Assessment: affected population; qualitative and quantitative health estimate of health impacts**	**Recommendations to decision makers and stakeholders**	**Impacts of HIA on subsequent decisions/and or affected populations**
Project proposed by private developer to expand and built petroleum refineries facilities and petrochemical factories	Community participation and health risk assessment and monitoring (health risk assessment and air monitoring)	-40 volatile organic compounds (19 of them were classified as human carcinogenic agents with concentration >1.3-693 times USEPA standard) -NOx and SO2 emitted from power plants and industrial production processes -Ground water (80 local wells heavy metal > 6-151 times of Thai standard [a] -Hazardous waste management (illegal dumping of waste) -Respiratory health rate in residents increase compared with other provinces -Lung cancer and leukemia rate increase (almost 3 times) -Physical exam of 20 plants found 483(19%) of employees were at risk (n=2,461) -Mental health problem 11 times higher than national average rate	The standard level of exposure of 9 volatile organic compounds has been promulgated. NOx and SO2 concentrations would exceed air quality standards BOD and metal levels(Cu, Ni, Mn, and As) exceed allowable standard Hazardous waste treatment facilities are of insufficient capacity Physical examination and health surveillance program Required occupational medical care and treatment Mental health survey	-The Court ruled that Map Ta Phut was a "pollution control zone" that obliged the "authorities to measure soil and water quality regularly and to come up with a plan to reduce pollution. -The court decided in September 2009 to suspend seventy-six projects due to absence of health impact assessment required under Article 67 of the 2007 Constitution.
Kwaenoi dam, Phitsanulok Province,	HIA framework and procedure	Identified the potential health impacts	Baseline of health risk indicators -Malaria, respiratory diseases, diarrhea, parasites -Occupational accidents and injuries -Sexual transmitted diseases(STDs) Develop HIA tools -Questionnaire, focus group and stool examination	-Provide clean water supply -Construct worker camps or housing with sanitation facility supports and waste management -Raise awareness of disease prevention and protection -Establish outbreak response teams with competent surveillance system for communicable diseases.

a= Heavy metals include cadmium, iron, manganese, lead, and zinc

Discussion

The progress in development of HIA into EIA has been demonstrated in Thailand. The Office of Natural Resources and Environmental Policy and Planning (ONEPP), MONRE plays a vital role for promulgating EIA and submitting EIA report. However, the difficulty in implementing HIA into EIA is recognized as well as the tools and guideline practices are still needed to clarify in Thailand. The implementation of HIA, therefore, still faces many obstacles, especially in such complex policy sectors as agriculture or environment. The uncertainties, lacks of evidence base, difficulty to implement HIA in political and cultural contexts are contributed to decision making and remain developed [4].There are also difficult to demonstrate the health outcomes of the HEIA approach due to confounding factors. For instance, health outcomes could cause from several factors and each cause can have different outcomes. Therefore, the approach to assess the health determinants is complicated. The recommendations for increasing HEIA capacity buildings are including 1) the developing tools and guidelines for implementations in each project types, 2) training HIA experts and conducting HIA courses, 3) participating of private agencies and companies, 4) integrating all parties and community participation and environmental justice including HIA communication, and 5) participating of public and political engagement.

The existing HIA tools and methods are still limited for applying the EHIA processes as well as methodology uses have to fit with available baseline data and resources. The HEIA evaluations require analytical validity, relevance and public participation [2-4]. The HEIA procedure should begin with an initial step for preparing potential data and resource available, demographic and population in community under guidance from advisory committee and assess the EHIA plan according HIA protocols and pragmatic guidelines. The implementations for HEIA are required several mixed methods in both qualitative and quantitative measurements. In some cases of quantitative evaluation, for instance, the qualitative measurement for HIA outcomes for mental health assessment is more difficult than HEIA outcomes of effects of air pollution exposure. Air pollution measurements can be quantified by analytical tools such as air samplings.

Recently, there has been only one published HEIA guideline for water resource development project [53,58]. In guideline practices, the HIA approaches for water resource development projects are included integrated methods, ranging from checklists to multistep processes of analytical measurements. Importantly, the context of HEIA applications and policy involvement should participate by stakeholders and affected populations for the EHIA. In addition, it needs to identify HIA methods best suited for evaluating specific types of projects. However, the more steps that stakeholders involved and participated in, the more time frames and resource uses are required. In addition, it is needed to develop strategies that improve visibility of public health populations.

The development of HEIA guidelines for selecting appropriate HIA tools based on context and resources available for accessibility is required. The HIA measurements would be benefits if available data from the public organizations and involved parties have been accessed and well documented that the MONRE, MOI and MOPH should set up the committee to consider the HIA database. There also needs to improve quantification of effects of changes in health determinants, such as specific health impacts of changes in range of personal, social, economics, and environmental factors that influence health status. The important to build and maintain database that includes inventory of HIA tools and guide to choice of HIA tools for suitable projects. Systematic reviews of health impacts for range of policies and projects can be benefits for HIA inputs. HIA tools and methods from Europe, USA, Canada, Australia and elsewhere should be adaptable for Thailand use in case there are well documented. Recently, a number of HIA tools and guidelines have been published as the protocols. For example, a number of tools for health impact quantification have been developed using modeling techniques through computing power. Such examples of HIAs can be conducted at varying degrees of detail, rigor and formality depending on needs and resources. Some of the tools are generic, while other has been tailored to deal with specific health determinants and diseases. For example, a Dynamic Modeling for Health Impact Assessment (DYNAMO-HIA) is a ready-to-use tool to project the effects of changes in risk factor exposure due to policy measures or interventions on disease- specific and summary measures of population health [48]. Integrated Assessment of Health Risks of Environmental Stressors in Europe/Health and Environment Integrated Methodology and Toolbox for Scenario Assessment (INTRARESE/HEIMTSA) has been used the full chain approach tracks the environmental health effects of policies from how they affect emissions of pollutants (to air, soil and water) through changes in pollutant concentrations and associated changes in human exposure to health impacts, later aggregated as disability adjusted life years (DALYs) [49].

There are needed resources for implementing HEIA such as trained experts and staffs. Public health officials need some additional training to conduct HIAs since public health officials presenting HIA results need to be credible and knowledgeable to influence decision makers. It is important to train multidisciplinary teams in HIA skills and educate community stakeholders about HIA process to increase HIA capacity and usefulness. There are totally 57 juristic persons (corporate body) registered and approved for conducting environmental impact assessment [4]. Most of them are from private companies only few experts from university staffs. One cooperate body has been suspended its license for conducting HEIA. Therefore, the increasing HIA specialists and experts in this field are potential and required. The integration of HIA course is essential and contributes to improve the HEIA enforcement. There are more than 10 HIA courses have been taught in universities in Thailand [59]. However, most courses are only elective subjects or in part of the subjects. The course outlines are either integrated into regular courses or optional courses focusing on health promotion and environmental management and healthy public policy. These courses mostly are providing for medical, public health, nursing, and paramedical students. In addition, the short course trainings for 3-4 days are also available for health professionals and interest persons. For teaching techniques, they use small group exercises and discussion. In philosophy of this courses use case studies to teach specific aspects of HIA methods by using local cases as practical and vivid examples. It would be pragmatic for accessibility to these courses and public participation by providing online distance courses and case studies, such as in Canada, US, and UK [22-24].

There should promote private sector or company to participate and plays more of role in project development in Thailand such as developed countries (USA and EU) [22-24]. In addition, there should examine how HIA achieved current levels of support and legitimacy in Thailand current situations and environmental contexts. There is still limited of the information or data at this point. HIAs as regulatory process may ensure legitimacy and build constituency and existing EIA laws and related laws (public health and environment act) may allow for HIA, for example, Canada and other countries have integrated EIA and HIA processes successfully. A number of barriers to adding HIA to existing regulatory EIA processes include adequacy of HIA predictions in litigious EIA environment, political and legal challenges to changing EIA practices, and need for resources in Thai's context. It is recommended to perform voluntary HIA pilot tests in Thailand to establish credibility and usefulness of HIAs before considering further regulatory approaches.

Development and engagement with impacted populations and communities are also needed. For supporting HIA community participation and environmental justice, community and population engagement promotes environmental justice and social equity, helps identify local relevant issues, aids community empowerment, and improves transparency of decision making. However, community involvement requires time and resources and may delay completion of HIA. In addition, local health baseline and disparities data may not be available and accessible. The available data at local levels should be integrated and connected such as development of program high performance application for hospital (HOSxP) database for electronic health care database, health surveillance database for disease statistics from disease surveillance system (e.g., communicable disease, non- communicable disease, suicide and injury), and air quality management by Pollution Control Department. It would be more benefits to develop guidelines and identify best practices to facilitate community involvement. In addition, there should train HIA practitioners in skills for community involvement such as cultural sensitivity and accountable listening. HIA therefore is a tool for local administrative organizations to apply in building a communal learning process on the quality of health, in presenting an option to protect and promote health, in advancing public health policies, and in encouraging local people to use their rights. There are several ways to apply HIA for developing local policy and plan, e.g., promoting occupations, reducing use of chemical pesticides, managing waste and preventing diseases and for preventing health hazards under the Public Health Act, 1991. HIA can be applied in the process and stipulated activities that are hazardous to health. It can be also applied in setting criteria and conditions for engaging in activities, in considering licenses, and irritants. In addition, HIA can apply for support decisions of local authorities on other matters, such as Section 67 and 287 of the Constitution or Section 11 of the National Health Act. The HIA tool can be used for local organizations and communities as community HIA (CHIA). The process is linked to customs, traditions, and the ways of life and beliefs of local communities. Moreover, members of a community for sometime have tended to engage in consultations or reach conclusions before starting any activity. Also, the HIA tool can be used for local agencies and communities in developing healthy public policy and capacity building. The approaches for assessing social and spiritual health impacts in local community could be benefits and fit to local settings.

The political support and public and non-public organizational alliances to build support for HIAs are also crucial one. Participants in HIA process and interactions with decisions with decision makers vary by organizations and projects. HIA experts and planers can use HIA to educate public health officials about constraints in planning, develop model timelines for HIA process, and develop model agreement for governance of HIA conduct. Finally, explore potential for various groups to take action on conducting HIAs, such as health officers, academia, and consultants. For training planner and decision makers in HIA, it is needed to target decision makers who can use HIA results and consider methods to incorporate health into formal decision-making processes so that health officials will be at table, for example, developing briefings, seminars, short courses, and case studies about HIA for planners and decision makers and create media attention to HIA process and develop incentive for HIA use, such as involving decision makers in HIA process, promoting HIA as part of improved policy making, and motivating communities to ask for HIA process.

The improvement and development for communication HIA tools to inform populations and decision makers about HIAs are required. For communicating the HIA findings, the potential audiences include planners, politicians, project developers, health agencies, media, community stakeholders, and academics. Nontechnical report, needed for political decision makers, community stakeholders, and lay audiences, should include background, health impact findings, and recommendations. Report for technically trained audience should include executive summary, scoping, literature review, assumptions, major health impact findings, and sensitivity analyses, level of uncertainty, discrepant views, and recommendations. It is needed to develop guidelines for HIA reporting formats to facilitate later comparisons and evaluation and create model HIA reports that can be used to educate decision makers about HIAs.

The Assessment of the HIA Tools Using both Qualitative and Quantitative Measurements (Phase II)

Section 2*: Determining occupational health risks and hazards at roofing cement processing factory*

The walk-through survey and key findings of personal and environmental samplings has been preliminarily assessed at the fiber roofing fiber cement factory.

Introduction

Several studies have been conducted and well documented related to cement dust exposure [8-19]. Epidemiological studies revealed that workers exposed to cement dust have an increased risk of suffering from acute in pulmonary dysfunction and chronic respiratory symptoms [8-13, 15-18]. Cement dust can cause health risks by skin and eye contact, or inhalation, depending on duration and level of exposure and individual sensitivity [15-16]. Workers in cement factory are exposed to various occupational health hazards in the different departments of cement factories. There are several processes in cement factory production in which airborne dust exposure among the workers is likely to be exposed. A review of cement studies has indicated that cement workers might be exposed to dust levels ranging 11–230 mg/ m^3 for total dust and 2–46 mg/ m^3 for respirable dust [8]. The chemical hazards arise from excessive air born concentrations, chemicals could occur through either inhalation, dermal or ingestion and through contaminated hands. These toxic chemicals may have acute or chronic effects on the workers [66]. However, no studies have been reported specifically in roofing fiber cement. In roofing fiber cement industry, cement dust is generated in several processes, including mixing and pouring process, racking and curing, and de-palleting and skid [60].

In Thailand, there are 3,873 establishments manufacturing related to cement tile, roofing materials, and related products with 69,300 employees (TIS code 57(1), 57(3), 58(1), and 67(3)) [46]. The export fiber cement is 1.3 billion tons per year, approximately

10,000 million baht. As this part, 70 % of the roofing fiber cement without asbestos use is being produced from two main companies in Thailand [61].

This study was part of the health risk assessment on respiratory symptoms and patterns of pulmonary impairments among roofing fiber cement industry. The main objective of this study is to investigate occupational cement dust exposure and assess the health hazards in the roofing fiber cement processing industry with implications for identifying strategies for prevention.

Materials and Methods

Study Population and Settings

A cross-sectional study was conducted at the fiber roofing cement factory in the South of Thailand. The purposive sample consisted of 122 of workers and employees.
The factory was established in 1974 as one of five factories in leading roofing fiber Cement Company in Thailand [60]. In working process and procedure of the roofing fiber cement factory, there are six main processes for producing roofing fiber cement materials, including mixing and pulping, racking and curing, de-palleting and skid, quality control, painting and spraying injection, and inspection and storage.

A walk-through survey was conducted during April to May 2011. This study conducted the survey used the survey template of Ministry of Labor [68]. The environmental samplings were conducted previously on October 2010 and April 2011 by the certified and accredited private company [67]. The records of physical exams and environmental samplings were also reviewed [67].

Roofing Fiber Cement Compositions and Processing Work Environment

The ingredients for producing roofing cement are including potassium and sodium bentonite, fibers (eucalyptus pulp and virgin pulp), polyvinyl alcohol (PVA), calcium carbonate, asbestos, and cement (Table 4.4). Recently, the asbestos has been substituted by PVA since late 2011 due to a ban on asbestos use in Thailand.

Table 4.4: The compositions of raw material using in roofing cement industry: a case study in one factory, 2008-2011

Ingredient Compositions	2008 (%)	2009 (%)	2010 (%)	2011 (%)
Potassium/sodium bentonite	N/A	N/A	0.10	2.49
Eucalyptus pulp	N/A	N/A	N/A	0.69
Virgin pulp	N/A	N/A	0.40	9.02
Polyvinyl alcohol (PVA)	0.07	0.01	0.34	3.15
Calcium carbonate (CaCO3)	9.70	5.05	0.48	34.65
Asbestos [a]	10.43	6.77	7.33	6.02
Cement	76.04	88.17	96.71	43.97

[a] Substituted with PVA after 2012; N/A = not use

Work Processes, Job Tasks, and Working Practices

In working process and procedure of the roofing fiber cement factory, there are 4 main processes for producing roofing fiber cement materials (Figure 4.1 & 4.2). First, cement bag is opened by a bag opener. Next, polyvinylalcohol (PVA), calcium carbonate, potassium and sodium bentonite are poured into the turbo mixer. Then, all ingredients are combined with mixing pulp followed by cement into the rod mill. Second, the mixing ingredients are weighed and rinsed water into slurry by control density before sending to racking and curing. Third, the raw materials have been transformed into sheet through curing process. The sheet has been prepared pre- and post-cure coating & drying and then spray assigned color. Finally, the sheet is stripped and inspected for quality checking and control. The final products are ready to be collated and packaging and stored in the warehouse. The chemicals and airborne dusts that can be sampled and presented in work environment are including respirable and total dust, chromium (III) compound, iron oxide fume, hydrogen chloride, methyl ethyl ketone (Table 4.8)

Figure 4.1: Mixing process of fiber cement factory (CFM = centrifuge ingredient mixing)

Figure 4.2 Racking, curing, post-cure coating & drying, depalleting, painting and packaging & storage

Personal and Environmental Dust Samplings

A total of 61 respirable dust and 66 total dust measurements were conducted for randomly selected workers from 10 occupational groups. Total dust was conducted using tared 5-µm filter with closed faced 37-mm Millipore samplers (NIOSH method 0500) whereas respirable dust using 5- PVC membrane with aluminum cyclone (NIOSH method 0600)[30]. Totally 5 respirable dust and 3 total dust samples were removed during the analyses since there were unexpected pump stop or not well sampling management and procedure. The arithmetic mean of respirable dust concentrations with each of occupational group was used in the calculation of the cumulative respirable dust exposure. The cumulative respirable dust exposure for representative workers was calculated as the sum of the products of arithmetic mean of respirable dust concentration and the years worked in the working areas, expressed as mg/m^3-years.

This study conducted the respiratory questionnaire interview used a modified version of Thai Thoracic Society and American Thoracic Society [29]. The main of questions included demographics, work history, use of respiratory protective equipment, smoking habits, and respiratory symptoms as well as spirometric measurements. According to a preliminary walk-through survey and an existing data records review, this study classified homogenous exposure groups (HEGs) [64-65] to estimate and classify cement dust exposure levels in different work settings. This was based on the concept that workers working in the same area for similar amounts of time are likely to have similar exposure levels. The workers were classified into two groups of high suspected HEGs (mixing and pulping, water injection, curing, de-pelleting and skid, spraying injection, and painting) and low HEGs (quality control, storage and driving and maintenance, office).

Results and Discussion

The total employees at roofing fiber cement were 122 workers (Table 4.5). Most of them were males (n =110; 90 %). Only twelve female employees were employed and working in office. The mean age of employees was significantly different between both groups (32.33 years old for HEG1 and 36.16 years old for HEG2, respectively). Most of them had attained higher or college education (HEG1 = 100%; HEG2 = 97%). There was significantly higher duration of employment in HEG2 (8.93 years) than in HEG1 (5.75 years). More than 70% of both groups were working for more than 5 years. There were more than 57% of HEG1 (n= 34) and 66% of HEG2 (n= 41) who had never smoked. The current respirable dust (1.26; SD 0.98 mg/m^3) and cumulative respirable dust (3.03; SD 4.08 mg/m^3) were significantly higher in HEG1 than HEG2 (0.34; SD 0.63 mg/m^3 and 2.29; SD 3.65 mg/m^3).

Table 4.5: Descriptive demographic characteristics of workers at roofing cement factory, by homogenous group of exposure (HEGs)

Characteristics	HEG1 [a] (n = 60)	HEG2 (n = 62)	*P*-value
Age (years) , mean (SD)	32.33(7.25)	36.19(8.12)	0.007 [b]
Sex			
• Male	60(100.00)	50(80.64)	<0.001 [c, d]
• Female	N/A	12(19.36)	
Height (cm), mean (SD)	167.98(5.70)	164 (7.40)	0.951 [b]
Weight (kg), mean (SD)	65.30(10.27)	65.18(11.81)	0.561 [b]
Education (%)			
• Primary	N/A	2(3.22)	0.918 [c, e]
• Secondary	15(25.00)	13(21.96)	
• Higher	45(75.00)	47(75.82)	
Tenure (years), mean (SD)	5.75(4.21)	8.93 (5.66)	0.001 [b]
Year employment (%)			
• < 5	34(66.70)	17(27.42)	
• 5-10	16(50.00)	16(25.81)	
• > 10	10(26.30)	29(46.77)	
Over time (8-hr) (%)	39(65.10)	28(46.72)	0.045 [b]
Smoking (%)			
• Never	34(56.67)	41(66.13)	0.283 [c]
• Current	18(30.00)	12(19.35)	
• Ex-smoker	8(13.33)	9(14.52)	
Pack-years, mean (SD)	1.99(3.25)	1.41(2.14)	0.473 [b]
Current respirable dust(mg/m^3), mean (SD)	1.26(0.98)	0.34(0.63)	0.006 [b]
Cumulative respirable dust(mg/m^3-yrs), mean (SD)	3.03(4.08)	2.29(3.65)	0.004 [b]

[a] HEG1 (mixing and pulping, water injection, curing, de-pelleting and skid, spraying injection and painting) and HEG2 (quality control, storage and driving and maintenance and office).
[b] Independent student’s T-test, significant at level of 0.05
[c] Chi-square test, significant at level of 0.05
[d] Compared only male workers
[e] Combined primary and secondary levels
N/A = Data not available

The workers were similarly acknowledged on occupational health and safety behavioral risks at work in both group (98% and 97%). They were also periodic trained on occupational health and safety (95%) in each year (Table 4.6). However, over half were rarely used mask protection (58%) for HEG2 whereas almost 44% for HEG1. These may be explained by the lack of occupational health and risk concerns among workers. Therefore, it needs to employ administrative procedures and education and training programs for workers to ensure adequate precautions and concerns. There were presented smoking habits among workers in both groups while they were working (HEG1 13% vs. HEG2 10%). Therefore, stop smoking while they are working was recommended and prevented possible accidents due to cigarette smoking. The HEG1 had higher percentage of cleaning workplace and equipment (81%) than HEG2 (59%). Similarly in both groups, they often used sweep more than vacuum and wet cleaning. These could mitigate to lower cement dust and chemical exposure at workplace if they were performing regularly.

Table 4.6: Occupational health and safety behavioral risks of workers at roofing cement factory, by homogenous group of exposure (HEGs)

Characteristics	HEG1 [a] (n = 60; %)	HEG2 (n = 62; %)	*P*-value
The workers know these procedures and acknowledge on occupational health risks	59(98.33)	60(96.77)	1.003 [b]
Periodic workers training on occupational safety	57(95.00)	59(95.16)	0.654 [b]
Mask using			
• Often	32(56.67)	22(41.94)	0.131 [c]
• Rare	25(43.33)	32(58.06)	
Smoking while working	8(13.33)	6(9.67)	0.802 [b]
Cleaning workplace			
• Often	49(81.67)	37(59.67)	0.052 [c]
• Rare	11(18.33)	23(37.09)	
Cleaning equipment	49(81.67)	37(59.67)	0.005 [b]
Cleaning equipment method			
• Vacuum	3(5.00)	2(3.22)	0.876 [c]
• Sweeping	31(51.67)	28(45.16)	
• Wet cleaning	6(10.00)	7(11.29)	

[a] HEG1 (mixing and pulping, water injection, curing, de-pelleting and skid, spraying injection and painting) and HEG2 (quality control, storage and driving and maintenance and office).
[b] Independent student's T-test, significant at level of 0.05
[c] Chi-square test, significant at level of 0.05

Environmental hazards and risks among roofing fiber cement workers have been conducted according to work procedures including chemical hazards (hydrogen chloride (HCl), chromium compounds (Cr (III) and ferrous oxide (Fe_2O_3)), noise levels, and light and heat exposure. The chemicals have been sampled only suspected high levels of exposure in racking and curing and painting and spraying departments. These chemicals were used in sieve cleaning (HCl) and injection for spraying the final products to assigned colors (Cr (III) and Fe_2O_3), respectively [67]. They were presented at levels between 0.021 $mg/m^3$to 0.067 mg/m^3 for HCl (3-sample) and less than 0.001 mg/m^3 for Cr (III) and 0.008 mg/m^3 for Fe_2O_3, respectively. All chemicals were found less than occupational exposure limits (OELs) [62] However, there were recommended for conducting and monitoring for every six months. High levels of Cr(III) dust exposure may cause respiratory tract irritation and skin irritation whereas high levels of iron oxide fume exposure may cause irritation of eyes, skin, respiratory system, cough, siderosis (a benign pneumoconiosis) [66]. In addition, high levels of hydrogen chloride exposure can cause corrosive to the skin and the respiratory system [66]. The noise exposure levels were detected highest at mixing and pulping areas (88-92 dB(A)) and followed by racking and curing sections(84-88 dB(A)), de-palleting and skid (84-87 dB(A)), painting and spraying (84-85 dB(A)), inspection and storage (81-84 dB(A)) and quality control (81-83 dB(A)), respectively (Table 4.7). The noise exposure levels at mixing and pulping were higher than OELs at 8-hr of time weight average (TWA) [68]. Therefore, the authors strongly recommended all workers at mixing and pulping or other stations wearing PPE such as ear plugs for discontinuous occurring new cases. At present, two cases were reported having hearing impairments (Table 4.7). The light levels were presented similar in each department between 180 to 210 Lux. These levels were under acceptable level of exposure at 8-hr TWA [68]. However, it would be better if they could increase light levels at mixing and pulping department. The dimly lit areas and wet floor have been reported occupational accidents from slips and falls (n =2) and electrical accidents (n=1) at the racking and curing areas [23] (Figure 4.5). The heat exposures were found highest at racking and curing department (32-34ºC), followed by de-palleting and skid (32-33ºC) and mixing and pulping (31-32ºC), respectively. High heat and un-operated ventilation system can cause sweat and hyperthermia [68]. Therefore, the authors recommended for operating the ventilation systems and using the cooling systems such as water spraying at high temperature areas, including racking and curing and de-palleting and skid sections.

Table 4.7 Environmental and occupational hazard samplings in the roofing fiber cement processing industry, by homogenous group of exposure (HEGs) [a]

Department	Noise dB(A)			Light (Lux)		Heat WBGT(ºC)	
	Sample [b] 1	Sample [b] 2	Sample [c] 3	Sample [b] 1	Sample [c] 2	Sample [b] 1	Sample [c] 2
Mixing and pulping	89	88	92	190	180	31	32
Racking and curing	86	84	88	185	200	32	34
De-palleting and skid	84	85	87	195	210	32	33
Quality control	82	81	83	210	205	27	28
Painting and spraying	84	85	84	205	195	30	32
Inspection and storage	82	81	84	205	N/A	27.5	28

[a] Environmental samplings records of the factory [67]
[b] Environmental samplings on October 2010 and
[c] Environmental samplings on April 2011
N/A = Data not available

Figure 1 The raw materials have been transformed into sheet through curing process. Wet surfaces causing slips and falls and electrical cables on wet surfaces cause electrocution

The concentration of the total dust exposure was higher for the workers in depalleting and skid (n = 10, mean 0.72 (SD 0.30) mg/m^3, painting and spraying (n = 6, mean 0.67 (SD 0.35) mg/m^3 , racking and curing (n = 12, mean 0.51 (SD 0.22) mg/m^3 than mixing and pulping(n = 14, mean 0.36 (SD 0.12) mg/m^3, storage(n = 8, mean 0.32 (SD 0.17) mg/m^3, and office(n = 8, mean 0.21 (SD 0.14) mg/m^3 ,respectively. However, the respirable dust levels were higher for the workers in spraying injection (n = 5, mean 1.31 (SD 1.29) mg/m^3, painting (n = 8, mean 1.11 (SD 0.87) mg/m^3, storage and driver (n = 5, mean 1.11 (SD 1.10) mg/m^3 than in work in other departments (Table 4.8; Figure 4.6). Total dust exposure levels were higher than and incompatible with respirable dust levels at mixing and pulping, racking and curing, and de-palleting and skid on average. These may be occurred due to variability in within and between workers and occupational exposure classification in HEGs. In addition, the variations in different days of samplings may be occurred [66-67].

A few previous studies related to respiratory symptoms and illnesses among cement workers showed higher risk of pulmonary dysfunction, pnuemociosis, bronchitis, emphysema, and others [8-19]. Both environmental and personal dust exposures were found lower than previous studies and under limit of allowable dust exposure at 5 mg/ m^3 for respirable dust and 15 mg/ m^3 for total dust [8, 13, 16, 18, 62]. At position personnel they are out of the dust either in enclosed and filtered cabins or so they are working upwind of dust emission as well as use wet processes to prevent dust generation and water suppression to prevent dust spread. In addition, the authors suggested applying hierarchy of controls through engineering controls to minimize emission, release and spread of dust such as using a local exhaust ventilation system for protection cement dust at mixing areas and hazardous chemical exposure at spraying area by using box shield. Even though the total dust and respirable dust exposure levels were lower than legal limitation of dust exposure levels, this study suggested that improving working environment and conditions play a crucial role to prevent occupational hazardous agents and minimize exposure risks to workplace hazards in the cement factory. The historical reduction in exposed workers is due to a combination of regular medical surveillance, reduction in exposures such as compliance with a regulatory exposure standard, the prohibition of specific tasks associated with high risk and the use of adequate dust suppression systems such as ventilation and wetting down.

Table 4.8: Total dust exposure levels of roofing fiber cement workers, by department

Department	Cement dust level (mg/m^3)[a]				
	No. collected samples	Mean	SD	Min	Max
Total dust samplings[a]					
Mixing and pulping	14	0.36	0.12	<0.01	1.44
Racking and curing	12	0.51	0.22	<0.01	2.21
De-palleting and skid	10	0.72	0.30	<0.01	2.25
Quality control	9	0.21	0.14	<0.01	0.91
Painting and spraying	9	0.67	0.35	<0.01	2.21
Inspection and storage	9	0.32	0.17	<0.01	1.17
Total	63	0.45	0.28	<0.01	2.25
Respirable dust samplings[b]					
Mixing and pulping(n=7)	7	0.21	0.24	<0.01	0.62
Racking and curing(n=15)	12	0.43	0.75	<0.01	2.21
De-palleting and skid(n=11)	7	0.19	0.26	<0.01	0.72
Quality control(n=7)	3	0.37	0.64	<0.01	1.12
Painting and spraying(n=27)	13	1.18	0.87	<0.01	3.10
Inspection and storage(n=55)[c]	14	0.66	0.94	<0.01	2.23
Total	56	0.61	0.84	<0.01	3.10

[a] Using tared 5-µm filter with closed faced 37-mm Millipore samplers (NIOSH method 0500)

[b] Using 5- PVC membrane with aluminum cyclone (NIOSH method 0600)

[c] No. of subjects including office workers (n = 19) and maintenance (n =14)

Figure 4.3 Total and respirable dust exposure at de-palleting and skid may cause irritation and inflammation of the eyes, and aggravate pre-existing respiratory symptom conditions.

The periodic medical exams and chronic health conditions were similar in both groups. Most of them were performed physical examinations. The allergy symptoms were highest among them, approximately 20% (Table 4.9). For improving surveillance of exposures, injuries, and respirable diseases, the recorded data should be employed and compatible with available data record from the Epidemiological Data Survey of Ministry of Public Health. The periodic physical examination and personal and environmental samplings are highly recommended and dissemination of surveillance data to assess risks and identify trends.

Table 4.9: Physical exams and presence of medical records for each workers of cement workers, by homogenous group of exposure (HEGs)

Physical exams	HEG1 (n = 60 ;%)	HEG2 (n = 62 ;%)	P value [a]
Periodic medical examination	57(95.00)	60(96.77)	0.283
Physical exams (abnormal)	3(5.00)	1(1.61)	0.300
Noise-induced hearing loss test	57(93.56)	58(93.54)	0.157
Noise-induced hearing loss	N/A	2(3.23)	N/A
Pulmonary function test	57(95.00)	60(96.77)	0.284
Pulmonary function defect	1(1.67)	1(1.61)	0.292
Chronic diseases			
• Asthma	1(1.67)	1(1.61)	N/A
• High BP	4(6.67)	3(4.84)	0.429
• Allergy	14(23.33)	12(19.35)	0.243
• Diabetes	N/A	1(1.61)	N/A

[a] Independent student's T-test, significant at level of 0.05
N/A = Data not available

The HEG1 group had a significantly higher prevalence than the HEG2 group for chest tightness (OR = 3.24; p = 0.030) and insignificantly higher prevalence than the HEG2 group for chronic cough (OR = 1.25), shortness of breath (OR = 1.61), and wheezing (OR = 1.83) after adjustment for age, duration of employment, pack years of smoking, and education (Table 4.10). Since this factory is operating throughout 24-hr, the HEG1 was working over time (65%; n =39) more than HEG1 (46.72%; n =28). Over time workload and excessive speed on work stations can cause stress related symptoms such as anxiety, insomnia, digestive problems and fatigue [69]. The repetitive work, forceful motions of upper limbs, constrained neck postures for sorting, prolonged standing for grading and sorting at mixing and pulping and racking and curing can cause musculoskeletal cumulative trauma disorders, for instance, neck pain, shoulder girdle pain, elbow pain, wrist pain, and lower backache [69].

Table 4.10: Prevalence of chronic respiratory symptoms of cement workers, by homogenous group of exposure (HEGs)

Symptoms	HEG1 (n = 60)	HEG2 (n = 62)	OR [a]	95% CI	P value [b]
Coughing	28 (46.67%)	27 (43.54%)	1.25	0.60-2.62	0.541
Chest tightness	16 (26.67%)	6 (9.67%)	3.24	1.15-8.89	0.030
Shortness of breath	15 (25.00%)	9 (14.52%)	1.61	0.62-4.11	0.321
Wheezing	11 (18.33%)	6 (9.67%)	1.83	0.62-5.40	0.274

[a] Analyzed using logistic regression adjusting for age, tenure, pack years of smoking and education.

[b] Significant at p value of < 0.05

***Section 3**: Assessment of Self-Health Risk among Affected Populations nearby the Roofing Fiber Cement Factory*

This study aim was to assess how the affected populations determined their own health risk assessment. This study employed the survey toolkits for testing self-health risk assessment and their comments on their health.

Introduction

The understanding of self- health risk assessment (HRA) for possible effects and impacts on human health and the procedures of health impact assessment (HIA) are not well-documented. Mostly health studies were conduct self-reported data to assess the risk factors and health behaviors such as smoking, risk screening for diabetes, and heart disease [70-72]. Such studies have been widely used to measure health status and as a tool for disease and mortality risk screening [73-74]. Few studies have been conducted to assess self-HRA in HIA procedure [4, 75-76]. The framework and approach within HIA protocol implementation in Thailand, however, allows key stakeholders and affected populations to participate at the beginning and ongoing HIA procedures [2, 4]. They can participate in public hearings throughout different stages including in the initial steps of the screening process- identifying points of health impact, prevalent risk factors in the public scoping process, and estimating change in health outcome appraisal within public reviewing process [2, 4]. However, there is great opportunity for a number of limitations and obstacles need to be scrutinized for further directions [2]. In Thailand's conception of health, the component of a healthy state of being is defined as "physical, mental, social and spiritual well-being" [2]. This term has been redefined as a broader perception of health. Specifically, the spiritual health aspect has been taken into consideration when conducting the HIA process [3,77].

In fiber-cement roofing factories (FCR), work processes consist of 4 main processes for material production. First, cement bags are teased by a bag opener and then mixing pulp and sodium bentonite are poured into a turbo mixer. After all materials are combined, it is followed by cement into a rod mill. The mixing ingredients are then weighed and rinsed by water into slurry by controlled density before being sent to the rack and cured. Raw materials are then transformed into sheet through curing process. The sheet has been prepared with pre- and post-cure coating and drying, and are then sprayed the assigned color. Finally, the sheet is stripped and inspected for quality check and control. Finally, the final products are ready to be collated, packaged, and stored in the warehouse. The chemicals and airborne dusts that can be found and sampled in this work environment include inhalable and total dust, chromium (III) compound, iron oxide fume, hydrogen chloride, methyl ethyl ketone [60].

There are several processes in roofing fiber cement factory production, where airborne dust exposure among workers is likely. Previously, a walk-through survey was conducted by Thepaksorn et.al (2012) that includedmeasuresments of environmental and personal dust samplings. The meanexposure levels of total cement dust in the factory were 0.45(SD 0.28) mg/m^3 and respirable dust exposure levels were 0.61(SD 0.84) mg/m^3. Therefore, the roofing fiber cement productions and emissions could be one of the major suspected sources of cement dust exposure that caused respiratory health risks and paid attention from the population concerns and complaints in the surrounded community [78]. In a cross-sectional study, Thepaksorn et al. (2012) observed that the exposed group had significantly higher prevalence than the unexposed group for shortness of breath (OR = 2.19). The ventilated respiratory function values (FEV1 and FVC) were slightly lower for the exposed group.

In order to achieve the objectives of this study, the authors developed self-HRA questionnaire assessments, in which the variables were integrated from health determinants and a healthy state of well-being. In-depth interviews were also conducted to assess opinions on health risks due to pollutant exposures from roofing fiber cement factory. The aim of this study is to assess whether the data collected through the self-report questionnaires is associated with their health status. In addition, published studies examining cement dust exposure of populations living in varied vicinities of the factory are scarce. The application of the self- HRA among populations living near the roofing fiber cement factory where the HIA tool can be used to quantify levels of public scoping is found to be a valuable addition in the HIA process. Consequently, the suggested tool has been included to enhance the scope of the study.

Methods

Study Design and Population Settings

As a part of the study on developing HIA tools for cement factories, this cross-sectional study was conducted between July and September 2011 among populationsliving nearby the roofing cement factory in the South of Thailand.

There were a total of 6,746 people in our population (male = 3,220; female=3,376). The health data registries were accessed and extracted from two corresponding Health Centers. According to Kongsoa Health Center (KHC), there were totally 2,140 populations living factory within a 2-km radius of the factory whereas 4,606 population living (Kaewsaen Health Center; KSC) within a 5-km radius from the factory.

The descriptive characteristic data for assigned populations were extracted from the Java Health Center Information System (JHCIS) of KHC and KSC. This program has been recorded since 2009 [79]. The registered data have been recorded according to basic data classified into 21 family folders for out-patient registries. Health Centers have been promoted as health promotion hospitals, focusing on health promotion and disease prevention. Health centers provided integrated health service, including health promotion, curative disease preventive, and rehabilitation in the catchment area for individual, family, community and environmental health [79].

The sample size employed in the study allowed the estimation of sensitivity and specificity at a 95% confidence interval of width ± 10% was 90 in each group [80]. A sample size of 96 participants living within 2-km and 101 participants living within at least a 5-km radius from the roofing fiber cement factory was surveyed for this study. A total of 14 questionnaire surveys for participants living within 2-km and 9 questionnaire surveys for participants living least 5-km were removed during the analyses since they were not completed.

The semi-structured questionnaire interviews have been developed according to health determinants for self-HRA aspects of health dominants including physical, mental, social, and spiritual health aspects in both positive and negative statements (Figure 4.4). There were 4 positive and negative statements for mental health impacts, 6 positive and 4 negative statements for social health impacts, and 5 positive and 3 negative statements for spiritual health impacts. Face-to-face interviews of each were conducted with 10 representatives. The authors gave a brief explanation of the HIA and the purpose of the study. The discussions were semi-structured using a list of open-ended questions (Table 4.11). This study was approved by the ethical committee of Chulalongkorn University Review Board. All of the participants have been clearly informed of the purpose of this study and agreed by signing their consent forms.

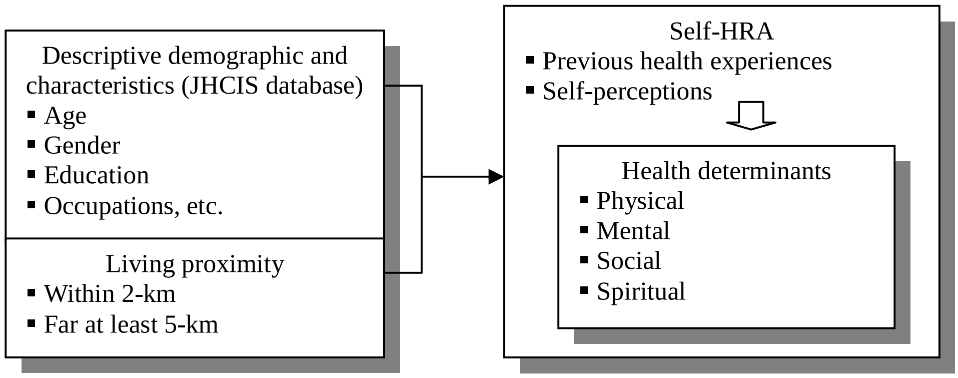


Figure 4.4: Logical framework for self-HRA of associations between health determinants and living proximity

Table 4.11: An example list of open-ended questionnaire interviews

Health determinants	Descriptive scopes and example of questions
1. Physical health	According to the complaints and concerns of cement dust exposure including that it may cause respiratory health symptoms and diseases, do you or your family members have experiences or symptoms related to respiratory health diseases (symptoms) in the last 3-months? How do you feel about the roofing cement factory being located near the community?
2. Mental health	For assessing how populations feel about the factory being located close to the community, how do you feel or do you worry about the factory being operated near your community and do you worry about being exposed cement dust?
3. Social health	The social health impacts include the relationships between the factory owner, employees and populations, work employment and living, social, and environmental changes. What do you think are the impacts of having the factory on the community and social changes in the community?
4. Spiritual health	The roofing cement factory has affected the population's spiritual health. Do you think the owner (employees) of the factory contribute or support the cultural activities and relationships in the community?

Statistical Analysis

The data analyses were derived by SPSS *version 18* for Windows (Chicago, IL, USA). Means and SD were used to characterize the difference between both groups including descriptive demographic characteristics, frequencies and percentages. The score for each question has been coded and rated (positive statement; yes (1); no (0) and negative statement; yes (0); no (1)). The evaluative criteria for health impacts have been classified into three categories and calculated in percentage (positive impacts =score 67-100%, between positive and negative impacts = score 34-66%, and negative impacts = score 0-33%), respectively. The chi-square was used to detect differences in the frequencies of categorical characteristics such as age, sex, education, and occupation between the groups. An independent t-test was used when analyzing difference in means between group of exposure and control group. A p-value of less than 0.05 was considered statically significant. The questionnaire interview results were grouped into four aspects.

Results

Data from the JHCIS online records between 2009 and 2011shows the number and prevalence of six leading chronic diseases at KHC were 200.77 per 1,000 for respiratory diseases, 100.92 per 1,000 for digestive system, 100 per 1,000 for cardiovascular disease, 68.30 per 1,000 for skin diseases, 64.32 per 1,000 for musculoskeletal symptoms, and 27.87 per 1,000 for hypertension, respectively. In KSC data, the number and prevalence of six leading chronic diseases at KHC were 174.76 per 1,000 for respiratory diseases, 80.24 per 1,000 for cardiovascular disease, 76.12 per 1,000 for digestive system, 39.16 per 1,000 for musculoskeletal symptoms, 30.77 per 1,000 for skin diseases, and 23.34 per 1,000 for hypertension, respectively. The respiratory symptoms and diseases were reported, including common cold and fever, pneumonia, and sore throat infection (Table 4.12).

Table 4.12 Number and prevalence of 6-leading outpatient according to JHCIS database of Kongsoa Health Center and Kaewsaen Health Center, 2009-2011

Diseases	Kongsoa HC (n= 6,530 [a])		Kaewsaen HC (n= 13,584 [a])	
	No.	Rate per 1,000	No.	Rate per 1,000
1. Respiratory system	1,311	200.77	2,374	174.76
2. Digestive system	659	100.92	1,034	76.12
3. Cardiovascular disease	653	100.00	1,090	80.24
4. Skin disease and coetaneous	446	68.30	418	30.77
5. Musculoskeletal	420	64.32	532	39.16
6. Hypertension	182	27.87	317	23.34

JHCIS = the use of graphic user interface according to data record of MOPH by 18 folders

[a] A number of total populations summed up of 3 years, 2009-2011

Ninety six participants of near and 101 subjects of far group were participated in this study. The mean age of near group was insignificantly lower than far group with 38.8 years old on average compared to 42.6 years old. The ratio of male to female was significantly different between both groups (p = 0.011) by response rate of male in near group was lower than far group. There were insignificantly different in marital status (p = 0.140), educational levels (p = 0.588), and occupations (p = 0.883) between both groups. The majority of participants were married (70%) and agriculturist (72%) in both groups (Table 4.13).

Table 4.13 Descriptive characteristics of self-health risk assessment for participants who live near and far from the factory

Characteristics	**Near** [c] (n=96)	**Far** (n=101)	**P value**
Age (years), mean (SD)	38.77(14.87)	42.62 (18.17)	0.101 [a]*
Sex (%)			
• Male	28(29.17)	47(46.53)	0.011 [b]*
• Female	68(70.83)	54(53.47)	
Status (%)			
• Single	21(21.87)	23(22.77)	0.140
• Married	67(69.79)	75(74.25)	
• Divorce/separate	8(8.34)	3(2.98)	
Education (%)			
• Primary	36(37.50)	43(42.57)	0.588
• Secondary	35(36.45)	35(34.65)	
• Higher	25(26.05)	23(22.78)	
Occupation			
• Agriculturist (rubber plantation and palm oil)	70(72.92)	74(73.26)	0.883
• Temporary workers	16(16.67)	16(15.84)	
• Own business (trading -small business)	5(5.20)	4(3.96)	
• Governmental and public enterprise employees	5(5.21)	7(6.94)	

[a] Independent student's t-test
[b] Chi-square test
*Significant at level of 0.05
[c] Near = within 2 km; far = at least 5 km far from the factory

Four main health determinants of self-HRA were physical, mental, social, and spiritual aspects and were classified in both positive and negative statements. The near population group had significantly lower ratings in health related issues due to physical health due to nervous systems than far population group ($p = 0.032$). The near population group had significantly higher positive ratings in mental health impacts than far population group ($p < 0.001$) whereas they had significantly lower negative rating such as worries and concerns ($p=0.022$), pollutant releases($p=0.050$), environmental changes($p< 0.001$), and toxic and chemical exposed ($p=0.006$), respectively. The near population group also had significantly higher positive rating in social health impacts than far population group such as providing information ($p = 0.011$), good cooperation ($p = 0.002$), creating jobs ($p < 0.001$); conversely whereas the near population group had significantly lower negative rating in increasing drug uses and crime ($p = 0.018$). The near population group had significantly higher positive rating in spiritual health impacts than far population group such as humanize care ($p = 0.027$), human rights($p = 0.001$), culture preservation ($p=0.033$) and beneficial cooperation ($p = 0.008$), whereas the near population group had significantly lower negative rating in increasing income ($p = 0.033$)(Table 4.14).

Table 4.14 Self-health risk assessment of participants who live near and far from the fiber cement factory

Health determinants	Near (n=96) Yes (%)	Near (n=96) No (%)	Far (n=101) Yes (%)	Far (n=101) No (%)	P value
1.Physical assessment aspects (in last 6-month)					
1.1 Anyone of your family members or you has respiratory symptoms and illnesses such as allergies, common cold, coughing, nasal congestion, difficulty breathing, and dry mouth.	72(75.00)	24(25.00)	70(69.31)	31(30.69)	0.364
1.2 Anyone of your family members or you has problem related to nervous systems such as headache, dizziness, and drowsiness.	49(51.04)	47(48.96)	66(65.34)	35(34.66)	*0.032**
1.3 Anyone of your family members or you has skin or dermal diseases such itchy skin, rash and eczema.	42(43.75)	54(56.25)	50(49.50)	51(50.50)	0.381
2.Mental assessment aspects					
2.1 You are happy even though the factory located near your neighborhood.	71(73.96)	25(26.04)	44(43.56)	57(56.44)	*<0.001**
2.2 You are satisfied that the factory is located near your neighborhood since it improves your community.	73(76.04)	23(23.96)	47(46.53)	54(53.47)	*<0.001**
2.3 You are satisfied that the factory creates job opportunities and income.	65(67.71)	31(32.29)	56(55.45)	45(44.55)	0.078
2.4 You are confident that the owner of the factory takes good responsibility for waste management and control.	40(41.67)	56(58.33)	35(34.65)	66(65.35)	0.308
2.5 You are worried or concerned that the factory was established in your community.	47(48.95)	49(51.06)	65(64.36)	36(35.64)	*0.022**
2.6 You are unhappy that the factory was established in your community since it creates toxic dust pollutions and releases chemical waste.	63(65.62)	33(34.37)	83(82.17)	18(17.83)	*0.050**
2.7 The factory has changed community environment in a way that threatens your life and living	38(39.58)	58(60.42)	65(64.35)	36(35.65)	*<0.001**
2.8 You are worried or stressed when you are exposed to dust, chemicals, or contaminated drinking water released from the factory.	61(63.54)	35(36.46)	81(80.19)	20(19.81)	*0.006**

Yes = agree or accept; No = disagree or deny; Type of positive statements (item: 2.1-2.4; 3.1-3.6; 4.1-4.5) and negative statements (item: 1.1-1.3; 2.5-2.8; 3.7-3.10; 4.6-4.8)
Independent student's t-test
*Significant at level of 0.05

Table 4.14 Self-health risk assessment of participants who live near and far from the fiber cement factory (cont.)

Health determinants	Near (n=96) Yes (%)	Near (n=96) No (%)	Far (n=101) Yes (%)	Far (n=101) No (%)	P value
3.Social assessment aspects					
3.1 Your community members or you have a good relationship with a responsible person from the factory.	59(61.45)	37(38.55)	53(52.47)	48(47.53)	0.237
3.2 The representative of the factory gives health information to you.	49(51.04)	47(48.96)	34(33.66)	67(66.34)	*0.011**
3.3 The owner or employees and your community members have good cooperation.	66(68.75)	30(31.25)	47(46.53)	54(53.47)	*0.002**
3.4 The factory establishment creates job employment and improves economic and social ties in your community.	76(79.17)	20(20.83)	47(46.53)	54(53.47)	*<0.001**
3.5 After the factory was established it improved your quality of living.	40(41.67)	56(58.33)	35(34.65)	66(65.35)	0.337
3.6 The factory owner supports and facilitates environmental improvement in the community such as waste management and recycling.	34(35.42)	62(64.58)	31(30.69)	70(69.31)	0.478
3.7 Advantages provided by factory? job employment increase the gap between poor and rich family.	38(39.58)	58(60.42)	44(43.56)	57(56.44)	0.544
3.8 After the factory was established the community members placed more value on materialistic gains.	41(42.71)	55(57.29)	43(42.57)	58(57.43)	0.896
3.9 Since the factory was established the community has increased in drug use and crime.	41(42.71)	55(57.29)	59(58.41)	42(41.59)	*0.018**
3.10 After the factory was established conflict among community members increased.	47(48.95)	49(51.06)	47(46.53)	54(53.47)	0.734

Yes = agree or accept; No = disagree or deny; Type of positive statements (item: 2.1-2.4; 3.1-3.6; 4.1-4.5) and negative statements (item: 1.1-1.3; 2.5-2.8; 3.7-3.10; 4.6-4.8)
Independent student's t-test
*Significant at level of 0.05

Table 4.14 Self-health risk assessment of participants who live near and far from the fiber cement factory (cont.)

Health determinants	Near (n=96)		Far (n=101)		P value
	Yes (%)	No (%)	Yes (%)	No (%)	
4.Spiritual assessment aspects					
4.1 The owner and employees treat your community members with humane care.	51(53.12)	45(46.87)	38(37.62)	63(62.38)	*0.027**
4.2 The owner and employees have respect for human rights of your community members.	65(67.71)	31(32.29)	44(43.56)	57(56.44)	*0.001**
4.3 There is good cooperation between employees and your community members for preserving culture.	54(56.25)	42(43.75)	41(40.59)	60(59.41)	*0.033**
4.4 There is good cooperation and beneficial involvement between employees and your community members.	55(57.29)	41(42.71)	38(37.62)	63(62.38)	*0.008**
4.5 Forgiveness occurs between employees and community members when conflicts occur.	56(58.33)	40(41.67)	48(47.52)	53(52.47)	0.168
4.6 The factory owner takes advantage of the community in terms of natural resources and environment.	41(42.71)	55(57.29)	48(47.52)	53(52.48)	0.457
4.7 After the factory was established the community members gained higher income.	34(35.41)	62(64.58)	51(50.49)	50(49.50)	*0.033**
4.8 The community members are selfish in terms of community participation and involvement.	32(33.33)	64(66.67)	34(33.66)	67(66.34)	0.921

Yes = agree or accept; No = disagree or deny; Type of positive statements (item: 2.1-2.4; 3.1-3.6; 4.1-4.5) and negative statements (item: 1.1-1.3; 2.5-2.8; 3.7-3.10; 4.6-4.8)
Independent student's t-test
*Significant at level of 0.05

In cumulative ratings for self-HRA of each health determinant (Table 4.15), the near population group (30.34%) had significantly higher positive ratings in mental assessment than far population group (10.59%)(p <0.001) whereas they had lower ratings on negative impacts (14.61% vs 38.82%), respectively. Similarly to mental assessment, the near population group had significantly higher positive rating in social health impacts (28.42%) than far population group in social aspects (16.67%) whereas they had significantly lower negative rating in social aspects 9.47% vs 32.22%. The near population group (29.79%) had a similar positive rating in spiritual health impacts compared with far population group (27.08%), but the near population group (7.45%) had lower negative rating in spiritual health impacts than for far population group (29.17%).

Table 4.15 Summative score for self-health risk assessment of participants who live near and far from the fiber cement factory

	Near		**Far**		**P value** [b]
	No. (case)	(%)	No. (case)	(%)	
Mental assessment [a]					
Negative	13	14.61	33	38.82	<0.001
Between	49	55.06	43	50.59	
Positive	27	30.34	9	10.59	
Total	89		85		
Social assessment aspects					
Negative	9	9.47	29	32.22	<0.001
Between	59	62.11	46	51.11	
Positive	27	28.42	15	16.67	
Total	95		90		
Spiritual assessment aspects					
Negative	7	7.45	28	29.17	0.001
Between	59	62.77	42	43.75	
Positive	28	29.79	26	27.08	
Total	94		96		
Sum of 3 aspects					
Negative	6	6.90	24	30.00	<0.001
Between	58	66.67	51	63.75	
Positive	23	26.44	5	6.25	
Total	87		80		

[a] Negative = sum of impact (0-33 %); between = sum of impact (34-66 %); positive = sum of impact (67-100 %); [b] Chi-square test

The cumulative ratings for self-HRA of each health determinant were similar as summative score in each category. However, there were no significant differences for male (Table 4.16).

Table 4.16 Summative score for self-health risk assessment of participants who live near and far from the fiber cement factory

	Male		**P value** [b]	**Female**		**P value** [b]
	2-km [c]	**5-km** [d]		**2-km**	**5-km**	
Mental assessment [a]						
Negative	3 (12.00)	11(30.56)	0.237	10(15.87)	22(45.83)	<0.001
Between	17(68.00)	19(52.78)		31(49.21)	23(47.92)	
Positive	5(20.00)	6(16.67)		22(34.92)	3(6.25)	
Total	25(100.00)	36(100.00)		63(100.00)	48(100.00)	
Social assessment aspects						
Negative	5(18.52)	11(27.50)	0.698	4(5.97)	18(36.73)	<0.001
Between	15(55.56)	20(50.00)		43(64.18)	25(51.02)	
Positive	7(25.93)	9(22.50)		20(29.85)	6(12.24)	
Total	27(100.00)	40(100.00)		67(100.00)	49(100.00)	
Spiritual assessment aspects						
Negative	4(14.81)	11(23.91)	0.642	3(4.55)	16(32.65)	0.001
Between	14(51.85)	22(47.83)		44(66.67)	20(40.82)	
Positive	9(33.33)	13(28.26)		19(28.79)	13(26.53)	
Total	27(100.00)	46(100.00)		66(100.00)	49(100.00)	
Sum of 3 aspects						
Negative	3(12.00)	9(25.00)	0.154	3(4.92)	14(32.56)	<0.001
Between	16(64.00)	24(66.67)		41(67.21)	27(62.79)	
Positive	6(24.00)	3(8.33)		17(27.87)	2(4.65)	
Total	25(100.00)	36(100.00)		61(100.00)	43(100.00)	

[a] Negative = sum of impact (0-33 %); between = sum of impact (34-66 %); positive = sum of impact (67-100 %); [b] Chi-square test , [c] KHC; [d] KSC

The results of semi-structured questionnaire interviews for self-HRA from the populations in both positive and negative impacts according to the 4 health determinants, including physical, psychological, social, and spiritual aspects, have been grouped as follows:

1. Physical health impacts
   In both 2-km and 5-km population groups, the physical health impacts from respiratory health diseases and symptoms and skin diseases were not clearly demonstrated from the health reports. There were concerned that cement dust from the factory might cause respiratory health diseases and symptoms and allergies. These statements have been summarized as follows:

   "I have respiratory health illness symptoms such as runny nose, cough and sore throat sometimes, but I am not sure that is related to cement dust exposure from the roofing cement factory nearby."

   "*I used to work at this factory for four to five years around ten years ago, but right now I am working in my own rubber farm since at that time I did not have my own. At that time, I think cement dust exposure could have caused respiratory illnesses and symptoms if I did not wear protective mask.*"

   "*I got a cold and my family members also have one.*"

   "I never experience any respiratory symptoms and/or illnesses."

   "I had some kinds of skin irritation, so I think it could be because of skin contact with cement when I was working at mixing and pulping department."

2. Mental and psychological health impacts

In both populations who are living near and far from the factory, the mental and psychological health impacts from cement dust exposure and respiratory health diseases and symptoms are concerns. According to complaints about cement dust exposure during summer seasons with dry and warm climates, the populations feel they may not be safe from cement dust exposure from the factory.

These statements have been summarized as follows:

"I think it is good to have this factory in our neighborhood as it would create new jobs and have advantages in terms of improving our economy. However, I think populations who are living near the factory may not get these benefits since we are working in our own rubber farms or even working with someone else's rubber farms and could get paid higher than working in the factory. In addition, this factory employed mostly college educated workers, so some of us may not qualify for the jobs."

"I am very concerned about the released cement dust from the factory into the community. I think it would be not safe for us. We do not know what ingredients that they used for roofing cement production. I heard the employees at the factory have to have physical exam checks every year such as chest-x-ray radiography. Therefore, it could be dangerous to be exposed to some chemicals or other contaminants in the factory."

"I am not sure about waste management and control. It could be released from the factory if they discharge it into river or canal near the factory. They should report to us or allow us to examine the factory."

"I believe that if they have a good system for controlling dust and noise, it would not be present or make any health impact on populations' health near the factory."

3. Social health impacts
   In both populations who are living near and far from the factory, there are social health impacts from self-HRA from the factory.

   3.1 The relationships between the factory owner, employees and populations are examined?
   These statements have been summarized as follows:

   "I think the factory owner and populations have a good relationship. The factory manager and employees have some activities in the community such as they help to improve the playground at primary school. In addition, they also have sports games between employees and populations some years. I got a free t-shirt too."

   3.2 Work employment and living

   These statements have been summarized as follows:
   "Only a few of our residents are working at the roofing cement factory since we are working at our own rubber farm and we get paid well. Therefore, I think working at our own rubber farm it is better. We don't have to worry about being laid off"

   "In this factory, they unusually employ degree or diploma-graduated workers. Therefore, some of us do not quality to work there. However, for some kinds of jobs they employ lower educated employees for working on daily basis"

3.3 Social and environmental changes
These statements have been summarized as follows:
"I did not see any change in environment, but I agree that there are an increasing number of employed workers from other districts or provinces"

"I think it was not affected in terms of environmental and natural resource usage levels. The ingredients and raw materials have been imported from outside the community"

4. Spiritual health impacts
These statements have been summarized as follows:

"I think the owner and employees at the factory participated in community events such as religious ceremonies and elderly engagement activities."

"The factory owner has a program to develop and improve the facility in the community such as donating the roof fiber cement for a new building of the pre-school kid's center. They also support sport activities in the villages and sponsored and participated in the customs and religion. They donated the garbage bins and asked for living in the community".

Discussion and Conclusions

The primary interest of this study arose from the framework and approach within HIA protocols that encourage stakeholders and affected populations to participate in HIA procedures. They can participate in different initial to end steps of the project. This is the first attempt to integrate self-HRA into HIA tool assessment. The questionnaire interviews have been developed and tested for health impacts according to health determinants.

This study has demonstrated that the near population group (30.34%) had significantly higher positive rating opinions on mental assessment than far population group (10.59%) ($p < 0.001$), whereas they had lower ratings on negative impacts (14.61% vs 38.82%), respectively. They were satisfied for having roofing fiber cement established in their community in relevant semi-structured questionnaire interviews. They thought the factory would create new jobs and have advantages in terms of increasing their economy. However, some of them were concerned about cement dust exposure since they did not have any information about health risks. Similar to mental assessment, the near population group had significantly higher positive rating in social health impacts (28.42%) than far population group in social aspects (16.67%) whereas they had significantly lower negative rating in social aspects (9.47% vs. 32.22%). They commented on good relationships between the factory owner, employees and populations. However, they were concerned about work employment and living and environmental changes. The near population group (29.79%) had similar positive ratings in spiritual health impacts compared with far population group (27.08%), but the near population group (7.45%) had lower negative rating in spiritual health impacts than far population group (29.17%). This may not clearly demonstrate the spiritual aspects of community life for a practical conceptual framework for appraising spiritual aspects. The agreement between health statistic reports for both near and far groups were not inconclusive. The additional data analysis has warranted the relationships between health symptoms and self-HRA. Unfortunately, we could not perform further analysis and since limitations were encountered while conducting research.

Self-perceptions of health have indicating affected populations' opinion of their own present health status and/or past health risks, as indicators of health behaviors. Using self-reported data has several advantages. First, it is a convenient and cost-effective way for evaluating opinions on health risk perception from environmental risk exposure; specifically, in this case, roofing fiber cement productions and emissions could be one of the major suspected sources of air pollution causing respiratory health risks and given considerable attention within population concerns and complaints in the surrounding community. However, the response in self-administered questionnaires is likely a misclassification, resulting in under or overestimations of effects. In this study the spiritual health impact assessment is not only religious by meaning, but it can be also a non-religious perception such as self-fulfillment in a humanistic way. In order for such prevalence estimates and outcome measures to be useful, the self-report items must provide an accurate measurement of that which they are supposed to be measuring. Inaccurate self-report could lead to underestimation or overestimation of the prevalence of risk factors or health behaviors in the community or of the misclassification of risk status at the individual level, which could obscure causal relationships between risk factors and subsequent diseases.

This study has some limitations. First, within the cohort of this study we did not conduct the baseline or follow-up study to confirm consistency of their opinions. Secondly, we did not have the comparison data between both registered health centers; thus, clearly this data deserves further evaluation. The strengths of this study lie in its representative sample and different measured domains of health aspects. The follow-up and sufficient numbers of cases enables the required statistical analyses to be performed. Also, because of the JHCIS program, the data on medical records were reliable and inclusive. To be useful in developing HIA tools on risk assessment, tools need to be extensive in their ability to discriminate between persons at risks who living near and living far who are not at risk. Self-HRA alone or in association with other measures has been recommended as a substitute for longer risk-screening instruments, particularly for triaging those reporting worse health into more intensive evaluation and care management programs, but there is no consensus on this recommendation.

In conclusion, an association between self-HRA of positive mental, social, and spiritual could be effective for evaluating risk perceptions of populations in the affected community and living in the vicinity of the roofing fiber cement factory. This may raise health issues concerning HIA establishing cement factory in their community. They may request to conduct HIA according to National Health Act, 2007. Our findings contribute to previous knowledge on self-HRA for HIA development procedures. The main implication of this study relies on the living proximity effect on their awareness and concerns for health risks from environmental health risk exposures.

***Section 4**: Respiratory Symptoms and Patterns of Pulmonary Dysfunction among Roofing Fiber Cement Workers in the South of Thailand*

This study has been performed HRA at a cement factory according to the suspect and complaint from cement dust exposure from the factory.

Introduction

Respiratory health illnesses and symptoms among occupational cement exposure have been well documented and described [8-15]. However, the results of adverse respiratory health through respiratory symptoms and ventilatory function are not entirely consistent. Such findings of airway function impairments and respiratory symptoms have been conducted mostly in epidemiological studies. The causal associations between cement dust exposure and pulmonary diseases and related diseases have been studied by epidemiologic and animal studies [81]. The influenced mechanisms of dust deposition are impaction, sedimentation, and diffusion through respiratory system. Dust greater than 10 μm of aerodynamic diameter are generally captured in the upper respiratory tract, the nose and upper airway, whereas smaller particles can penetrate more deeply and reach the airways and alveoli regions, especially particles smaller than 2.5 μm have greater likelihood of reaching alveoli areas [81]. Fell et al, 2010 observed a significantly higher percentage of neutrophils among exposed workers compared with non-exposure group areas [19].

There have been a number of studies on effects of cement dust exposure on respiratory symptoms and illnesses [8-15]. A 4-year prospective cohort study in the European countries, Nordby et al, 2011 showed elevated relative risks of respiratory symptoms and airflow obstruction(OR = 1.2-2.6) [16]. In a follow up study of Zeleke et al, 2011, Forced Expiratory Volume in one second (FEV1) and FEV1 per Forced Vital Capacity (FEV1/FVC) were significantly reduced in exposed workers compared with the controls[4)]. Neghab and Choobineh, 2007 revealed significantly the respiratory symptoms among exposed cement workers. Similarity, chest radiographs of exposed workers showed various degrees of abnormality [13]. In a cross-sectional study, Mwaiselage et al,2005 observed an annual decline in FEV1 and FVC for cement dust exposed workers than control workers. In addition, they were at high risk of developing chronic obstructive pulmonary diseases (COPD) [8, 15]. Noor et al, 2000 and Yang et al, 1996 showed chronic exposure to cement dust had a greater prevalence of chronic respiratory symptoms and a reduction of ventilatory capacity [10, 14]. However, a few studies have found no significant difference in respiratory symptoms and negative impacts on pulmonary impairment indices [17-18].

The main objective of this study is to investigate the associations between respiratory symptoms, acute respiratory function and patterns of pulmonary dysfunction as well as personal and area dust samplings. The exposure- response relationship between cement dust exposure and respiratory symptoms and pulmonary dysfunction of roofing fiber cement workers has not yet been conducted. Interviewed of respiratory symptoms among these workers have also been conducted and associated with their ventilatory function. The total and respirable dust had been conducted among exposed workers. These finding on ventilatory function and respiratory symptoms among roofing cement workers were compared with those of unexposed groups who were of comparable age, similar socio-economic status and low levels and not occupationally exposed to cement dust.

Methods

Study Design and Population

As a part of a study on the respiratory health risk assessment, this cross-sectional study has been conducted between July 2011 and December 2011 among workers at the roofing fiber cement factory in the South of Thailand.

The sample size was enumerated based on the basis of an estimated prevalence of respiratory symptoms from previous studies [8,11]. A sample size of 110 exposed workers and 110 controls were required to achieve a power of 80%. There were totally 115 exposed workers and 236 unexposed workers. The exposed group included workers in the production line, consisting of mixing and pulping (n = 7), water injection(n = 6), curing (n = 9), depalleting and skid (n= 11),spraying injection(n = 6), painting (n = 21), quality control(QC; n = 7), storage and driver (n= 22), maintenance (n = 14), and other (n= 12) whereas the unexposed group included office workers (n= 19) and sub-contract workers (n=217). Sub-contract workers who work in accessories and were expected to be low cement dust exposure. We excluded female workers due to their small number and there were significantly different between both groups (unexposed workers; n= 102). Therefore, the exposed group included 115 male workers and 134 male unexposed or low exposed workers. The unexposed subjects were selected from workers who worked without contacting with cement dust or low dust exposure and those with no reported current respiratory illness, with no history of chronic respiratory diseases and no reported history of working in industries that they could be exposed to dust, chemicals, fumes or gases. Selection was restricted to male workers with at least 1 years work history.

Exposure Assessment

The factory was established in 1974 as one of five factories in a leading roofing fiber cement company in Thailand. It should be noted that there are using the similar materials in each factory The compositions of raw material uses are included potassium/sodium bentonite (2.92%), eucalyptus pulp (0.78%) , virgin pulp(8.55%), polyvinyl alcohol (PVA; 5.16%), calcium carbonate (35.67%) , cement (43.92%) respectively. The asbestos uses had been phased out since the end of 2011 in which previously it used to be approximately 6% of fiber cement processing. In roofing fiber cement factory, the working processes consist of cement mixing and pulping, water injection, curing, depalleting and skid, spraying injection, painting, quality control testing, and storage. According to preliminary walk-through survey and existing data record review, this study classified homogenous exposure group (HEGs) to estimate cement dust exposure levels in different worked settings. It is based on the concept that workers working in the same area for similar amounts of time are likely to have similar exposure levels. There were classified into three groups for exposed and unexposed workers, including 1) high HEGs (mixing and pulping, water injection, curing, depalleting and skid, spraying injection, and painting) ,2) low HEGs (quality control, storage and driver, maintenance, and office, and 3) unexposed groups. The authors observed workers did not use or consistent use personal protective equipment such masks protection. Most of the workers changed their jobs and did not hold the same job title for long period of time (Table 4.14). Therefore, individual cumulative duration of work in exposed areas was employed as surrogated measure of total dust exposure.

Study Questionnaire

The respiratory questionnaire interview used a modified version of Thai Thoracic Society and American Thoracic Society [10-11]. Face-to-face interviews of both exposed and control groups were conducted by well-trained occupational nurse. The main of questions included demographics, work history, use of respiratory protective equipment, smoking habits, and respiratory symptoms. The special attention was given to job title and duration of each job title. Smoking was quantified in pack years. Current smokers were those who were currently smoking at least 3 months prior to the interview and non-smokers as those who had never smoked more than 20 packs of cigarettes in their life time. Ex-smoker had quit at least one year before the survey. Pack years were defined as the number of packs (one pack = 20 cigarettes) multiplied by the number of years smoked. The principal investigators checked the questionnaire to ensure that the participants completed it.

Spirometric Measurements

The ventilatory function testing and results included forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and the ratio of forced expiratory volume in one second to forced vital capacity (FEV1/FVC). Pulmonary function was measured using the American Thoracic Society guideline[11)] with a portable spirometer (COSMED Inc., Italy). The spirometer was tested and calibrated by the representative company before conducting study. Participants did not smoke at least one hour before the test. At least three acceptable efforts were obtained in each participant. Spirometry measured values of FVC and FEV1 were compared with predicted normal values based on the regression equation for Thai men derived by Thai Thoracic Society [29]. Variations in the two best FVC and FEV1 were within 5% of each other. The spirometer was calibrated daily. Standing height and weight were measured using standardized equipment. Expect lung function scores were derived from the Siriraj Equation, which was developed using lung function testing from healthy non-smoking Thai population older than 10 years (n = 3,654) [83]. In addition, the pulmonary function impairment was calculated according to Thai Thoracic Society guidelines and assigned into four categories from no impairment to severe.

Sampling of Total and Respirable Dust

A total of 60 respirable dust and 22 total dust measurements were conducted for randomly selected workers from 10 occupational groups whereas 15 respirable dusts and 3 total dusts were conducted for the unexposed group using tared 5-µm PVC filter with closed faced 37-mm Millipore samplers (NIOSH method 0500) where as repirable dust using tared 5-PVC membrane with aluminum cyclone (NIOSH method 0600) [30]. Totally 5 respirable dust samples and 3 total dust samples were removed during the analyses since there were unexpected pump stop or not well sampling management and procedure. The arithmetic mean of respirable dust concentrations with each of occupational group was used in the calculation of the cumulative respirable dust exposure. The cumulative respirable dust exposure for representative workers was calculated as the sum of the products of arithmetic mean of respirable dust concentration and the years worked in the working areas, expressed as mg/m^3-years.

Results

One hundred and fifteen workers and 134 unexposed subjects were included in this study. The mean age of exposed group was an insignificant higher than control group with 33.1 years old on average compared to 31.6 years old. The mean height of exposed group was insignificantly slightly lower from control group whereas the mean weight of exposed workers was significantly higher than unexposed group. Most of the exposed group had had higher education (86%) as a twice of unexposed group (42%). Most of exposed workers had 6.4 years in working experiences on average (Max = 24 years) whereas unexposed group had 5.1 years in working experiences on average (Max = 15 years). Smoking was significantly lower among exposed workers compared with unexposed workers, and workers had similar a number of pack years of 2 pack-year on average. Almost 42% of them were current and ex-smokers in comparable percentages for exposed group whereas 57 % in the unexposed group. The exposed workers had an insignificant higher in current respirable dust (0.65 vs 0.32 mg/m3) and respirable cumulative dust (2.97 vs 0.99 mg/m3-yrs) exposure compared with the unexposed workers , respectively. More than half (54.78%) and unexposed (66.42%) groups were rarely wearing dust mask while they are working (Table 4.17). In logistic linear regression analysis between education and mask use, this study found no significant different between education and mask use (p = 0.87).

Table 4.17: Descriptive characteristics of exposed and unexposed workers at roofing cement factory

Characteristics	**Exposed** (n = 115)	**Unexposed** (n = 134)	P-value
Age (years) , mean (SD)	33.13 (7.56)	31.67(10.75)	0.22[a]
Height (cm), mean (SD)	167.17 (5.76)	167.98 (7.91)	0.36[a]
Weight (kg), mean (SD)	65.70(11.14)	62.66(10.01)	*0.02*[a]*
Education (%)			
• Primary	0(0)	23(17.18)	*< 0.001*[b]*
• Secondary	29(25.22)	54(40.29)	
• Higher	86(74.78)	57(42.53)	
Tenure (years), mean (SD)	6.35 (4.86)	5.05 (4.67)	0.05[a]
Maximum range(years)	24	15	
Smoking (%)			
• Never	67(58.26)	58(43.29)	*< 0.005*[b]*
• Current	33(28.69)	62(46.27)	
• Ex-smoker	15(13.04)	14(10.44)	
Pack-years, mean (SD)	1.98 (2.92)	2.16(3.51)	0.77[a]
Current respirable [c] dust(mg/m3), mean (SD)	0.65(0.85)	0.32(0.60)	0.15
Cumulative respirable dust (mg/m3-yrs), mean (SD)	2.97(4.01)	0.99(1.67)	0.05
Personal protective equipment (Mask)			
• Often	52 (45.22)	45(33.58)	0.07[b]
• Rare	63(54.78)	89(66.42)	

[a] Independent student's t-test.
[b] Chi-square test.
[c] 56 samples for the exposed workers and 13 samples for the unexposed workers
[*] Significant at level of 0.05

The exposed group had significantly higher prevalence than the unexposed group for shortness of breath (OR = 2.19; p = 0.02) whereas exposed group had an insignificantly higher prevalence than the unexposed group for chronic cough (OR = 1.34), chest tightness (OR = 1.62), and wheezing (OR = 1.67) after adjustment for age, duration of employment, pack-years of smoking, and education (Table 4.18).

Table 4.18: Prevalence of chronic respiratory symptoms in the exposed and unexposed groups at a roofing cement factory

Symptoms	Exposed (n = 122)	Unexposed (n = 127)	OR [a]	95% CI	P-value [b]
Coughing	54(44.26%)	49(38.58%)	1.34	0.79-2.24	0.27
Chest tightness	23(18.85%)	16(12.59%)	1.62	0.81-3.25	0.17
Shortness of breath	24(19.67%)	15(11.81%)	1.95	0.97-3.93	0.06
Wheezing	18(14.75%)	12(9.45%)	1.67	0.76-3.61	0.19

[a] Analyzed using a logistic regression adjusting for age, tenure, pack-years of smoking, and education.
[b] Significant at level of 0.05

The exposed group had similar prevalence of normal pulmonary function (64%) compared with the unexposed group. The exposed group (32%) had slightly higher mild pulmonary impairment than the unexposed group (27%) whereas the unexposed group had slightly higher moderate pulmonary impairment than the exposed group (Table 4.19).

Table 4.19: Patterns of pulmonary dysfunction in exposed and unexposed groups

Pulmonary function	Exposed (n = 122)	Unexposed (n = 127)	OR [a]	95% CI	P-value [b]
Normal	76(62.29%)	80(62.99%)	1.02	0.61-1.72	0.93
Mild	43(35.24%)	41(32.28%)			
Moderate	3(2.47%)	5(4.73%)			

[a] Analyzed using a logistic regression adjusting for age, tenure, pack-years of smoking, and education (OR= normal group compared with mild and moderate).
[b] Significant at level of 0.05

The estimated ventilatory function values (FEV1 and FVC) were slightly and non significantly lower for the exposed group compared with the unexposed group whereas the exposed FEV1/FVC % had slightly higher the control group (Table 4.20).

Table 4.20: The estimated ventilatory function values (FEV1, FVC, and FEV1/FVC %) for the exposed and the unexposed workers

Characteristics	Exposed (n = 122)	Unexposed (n = 127)	P-value [b]
FEV1(L/s), mean (SD)	3.08±0.53	3.19±0.64	0.184 [a]
FVC(L), mean (SD)	3.49±0.59	3.60±0.70	0.185 [a]
FEV1/FVC(%), mean (SD)	88.68±5.55	88.57±5.51	0.509 [a]

[a] Independent student's t-test.
[b] Significant at level of 0.05

The estimated ventilatory function values for cigarette smoking were similar for current and ex-smoker by the exposed group had higher FEV1, FVC, and FEV1/FVC% compared with the unexposed group insignificantly on average. In contrast, there were slightly insignificant lower FEV1, FVC, and FEV1/FVC% for never smoker (Table 4.21).

Table 4.21: The estimated ventilatory function values (stratifying cigarette smoking habits) for the exposed and the unexposed workers

Characteristics	**Smoking Status**	**Exposed Group** (n = 115)	**Unexposed Group** (n = 134)	P-value [b]
FEV1(L/s) [a], mean (SD)	Never (n=125)	3.06± 0.59	3.05±0.71	0.96
	Current(n=95)	3.18±0.49	3.32±0.50	0.21
	Ex-smoker(n=29)	2.95±0.42	3.25±0.53	0.23
FVC(L) [a], mean (SD)	Never (n=125)	3.44±0.66	3.43±0.57	0.99
	Current(n=95)	3.64±0.54	3.76±0.59	0.31
	Ex-smoker(n=29)	3.33±0.44	3.57±0.45	0.31
FEV1/FVC(%)[a], mean (SD)	Never (n=125)	89.20±5.58	88.54±6.23	0.58
	Current(n=95)	87.59±6.16	88.40±5.19	0.49
	Ex-smoker(n=29)	88.46±5.32	90.68±4.35	0.38

[a] An independent t-test
[b] Significant at level of 0.05

The high HEGs (mixing and pulping, water injection, curing, depalleting and skid, spraying injection, and painting) had insignificant slightly higher respirable cement dust exposure levels (0.617 mg/m3) than the low HEGs (quality control, storage and driver, maintenance, and office) (0.607 mg/m3) and the unexposed group (0.397, mg/m3) (p=0.056). The mean FVC, FEV1 and FEV1/FVC levels of high HEGs exposed group were 87%, 86%, and 87%, respectively, low HEGs exposed group were 85%, 88%, and 90%, respectively whereas unexposed group were 87%, 87%, and 88%, respectively (Table 4.22). The pulmonary function tests of FVC, FEV, and FEV1/FVC levels were insignificantly different among high HEGs (p=0.84), low HEGs (p=0.79) compared with unexposed group(p=0.17). Multiple linear regression analysis with age, height, pack-years cigarette smoking, tenure, and cumulative dust exposure showed that only height was significantly associated with FVC (L) and FEV1(L/s) for exposed workers, but they did not show in unexposed group. Age was negatively associated with all ventilatory indices but not significantly.

Table 4.22: Respirable dust levels and spirometry results for roofing fiber cement workers, by similar homogenous exposure groups (HEGs)

Descriptive characteristics	No. collected samples/ subjects	**Mean**	**SD**	**Max**	**Min**	P-value [c]
Respirable dust levels (mg/m3), No. collected samples						
High HEGs [a]	39	0.617	0.887	2.237	0.001	0.056
Low HEGs [b]	17	0.607	0.831	3.107	0.001	
Unexposed	13	0.397	0.677	2.257	0.001	
*Pulmonary function tests (PFT%)**,** No. subjects*						
FVC						
High HEGs	25	86.88	9.83	106	63	0.841
Low HEGs	22	85.45	9.43	104	73	
Unexposed	41	86.95	10.68	111	70	
FEV1						
High HEGs	25	86.04	10.61	104	66	0.796
Low HEGs	22	88.27	9.35	113	77	
Unexposed	41	87.10	10.60	108	64	
FEV1/FVC%						
High HEGs	25	87.01	5.04	93.41	74.73	0.166
Low HEGs	22	89.69	2.97	95.22	84.32	
Unexposed	41	88.37	5.38	98.51	72.75	

[a] High HEGs (mixing and pulping, water injection, curing, depalleting and skid, spraying injection, and painting)

[b]Low HEGs (quality control, storage and driver, maintenance, and office

[c] ANOVA analysis adjusting for age, tenure, pack-years of smoking, and education and significant at level of 0.05

Discussion and Conclusions

This is the first epidemiological study of respiratory symptoms and pulmonary dysfunction indices of roofing fiber cement conducted in Thailand. Roofing fiber cement workers were exposed to cement dust during the production processes (mixing and pulping, water injection, curing, depalleting and skid, spraying injection, painting, etc.) The exposed workers who were directly working at production line were exposed to higher concentration of dust compared with others such as office workers. The respirable dust and total dust samples were collected show that dust levels did not exceed the allowable limited level of exposure in Thailand. The socioeconomic and demographic differences between the cement-exposed and unexposed workers showed similar in age, height, and weight, tenure, pack-years, current respirable dust, and cumulative dust exposure, except education background and smoking status.

This study has demonstrated that shortness of breath was significantly different among exposed and unexposed workers whereas coughing, chest tightness, and wheezing were found insignificantly different among exposed and unexposed workers. The previous studies on respiratory symptoms and pulmonary function deficits have showed different results. In a few studies, they demonstrated a higher prevalence of respiratory symptoms and varying in degree of pulmonary dysfunction [8-15]. In contrast, some other studies have failed to find any significant differences in pulmonary parameters and respiratory symptoms among cement workers and unexposed workers [17-18].

Our findings are partly in agreement with previous studies from the United States and Norway [17-18]. The insignificant reductions in ventilatory function values in exposed workers in this study were in agreement with similar observations by Abrons et al., 1988 and Fell et al., 2003. In addition, this cross-sectional design could not clearly demonstrate the causal relationship between cement dust exposure and pulmonary reductions and impairments in FVC, FEV1 and FEV1/FVC%. The differences in the ventilatory function between exposed smokers and non-smokers did not achieve statistical significance after adjusting for age, height and smoking. Comparing respiratory symptoms and pulmonary dysfunction indices between studies is difficult because many factors vary. In addition, some previous studies did not adjust for possible confounders of respiratory symptoms such as age, smoking status, as done in our study [9, 10, 14].

The insignificant findings may due to a number of reasons. Firstly, the effect of dust was probably not obscured by low tenure, because the workers had maintained their work just a short period of time (average 6.3 years) and relative young (average = 33 years old) compared with the previous significant studies that tenure more than 10 years on average [8-9,13,17]. Secondly, the fact that the dust exposure was really low in both exposed and unexposed groups. Therefore, the detection abilities to find an affect were most likely due to low exposure. From our findings and observations in this study, the relationship between cement dust exposure and pulmonary function impairments may influenced by the healthy worker effect. Since the exposed workers switched jobs often, they were not exposed for long enough to create health effects. Finally, smoking was significantly reported lower among workers compared with unexposed workers. This may cause no significant differences between exposed and unexposed groups. This study found no significant different between education and mask use (p= 0.87). The results also suggest that the mask use may not prevent respiratory symptoms and pulmonary reduction similar as previous studies [8, 84].

In conclusion, an association between decline in lung function and cement dust levels among roofing fiber cement workers suggests that the respiratory health of roofing cement workers should be protected. The insignificantly different in dust exposure and pulmonary impairments may be due low tenure and low level of dust exposure as well as the healthy worker effect may be occurred. Since more than half of exposed workers are rarely used personal protective equipment (PPE) such as mask protection, they are still at high risk of cement dust exposure. According to a walk-through survey and interviews, it should be noted that the workers felt uncomfortable for wearing protective mask for so long. In addition, they though the cement dust was presented at relative low levels and might not cause any respiratory symptoms and pulmonary impairments to them. The use of proper PPE while at work and the reduction and elimination of smoking by the exposed workers would help to protect them from developing more severe chronic respiratory diseases in the future. However, we strongly recommend use PPE such as mask protection and engineering control for cement dust reduction in working processes. The results of ongoing study of pulmonary radiographs could be used to confirm the possible pulmonary dysfunction and indices among cement workers.

***Section 5**: Developing Health Impact Assessment Tools in the Roofing Fiber Cement Factory in the South of Thailand*

Overall aims of this study were to develop the guideline practice for specific the roofing fiber cement industry. This paper summarized and described the HIA tool development and testing at selected the roofing fiber cement factory. The intervention was to integrate into different processes and make guideline into practices.

Introduction

The movement and continuous development of health impact assessment (HIA) has been progressed and participated from several involved Thailand's public agencies. Specifically, they encouraged the key stakeholders and affected populations to participate in conducting in each step of HIA procedures. The Thai Constitution and Health Care Reform Act have significantly played a vital role since 2007. There are two main types that have been established including HIA for healthy public policy is focusing on health promotion and civil participation and engagement and HIA in environmental impact assessment (EIA) is recognized as an approval mechanism for proposed projects with significant impacts on human health [1-2]. However, the implemental protocols and guidelines have been less well-defined into practices. Only general and descriptive guideline have been promulgated on the basis of 5-step, including screening, scoping, appraisal, reporting, and monitoring and evaluating in which addressed similar as WHO and some other international guideline practices [3, 24, 27, 41-42]. Therefore, the explore feasibility and implementation into practice are needed. HIA processes in many countries incorporate active participation of interested stakeholders. Some countries, for instance, Australia, New Zealand, and Canada have integrated HIA into project specific EIA legislation [3].

A number of HIA implementation from international experiences have been conducted and presented the methods and procedures, scoping and health determinants affected, assessment of both qualitative and quantitative health estimate of health impacts, as well as the impact of HIA on subsequent decision and affected population were concluded [29, 64-65,85]. However, only few reports on HIA implement and practice in Thailand were explored and documented. A case study of HIA implementations has been summarized according to HIA for healthy public policy whereas the individual project under submitted HIA in EIA has been rarely revealed.

Monitoring and evaluations of HIA effectiveness are important to advance the field, demonstrate value, document influence on decisions, improve quality, facilitate training, enhance institutional relationships, raise awareness of health impacts for decision makers, and examine adherence of processes to underlying values. Three types of HIA evaluation have been described, including 1) process evaluation examines how the steps of the HIA process were done, 2) impact evaluation assesses the effect on decisions made and documenting the cause and effect of observed changes can be difficult, and 3) outcome evaluation compares the health outcomes after implementation with those predicted by the HIA may be complicated by differences between the initial proposal and subsequent implementation [82]. Quantitative modeling of some health impact outcomes (e.g., mental health) is more difficult than modeling of environmental impact outcomes (e.g., air pollution). It has also been suggested that more extensive use of quantitative epidemiological techniques could be considered in HIA, including time series analysis and decision analytic modeling [82]. Such examples of modeling techniques through computing power are proposed at varying degrees of detail, rigor and formality depending on needs and resources. For example, a Dynamic Modeling for Health Impact Assessment (DYNAMO-HIA) is a ready-to-use tool to project the effects of changes in risk factor exposure due to policy measures or interventions on disease-specific and summary measures of population health [30]. Integrated assessment of health risks of environmental stressors and environment integrated methodology and scenario assessment or INTRARESE/HEIMTSA tool has been used the full chain approach tracks the environmental health effects of policies from how they affect emissions of pollutants (to air, soil and water) through changes in pollutant concentrations and associated changes in human exposure to health impacts, later aggregated as disability adjusted life years (DALYs) [49]. However, the implementation of HIA faces many obstacles, especially in such complex policy sectors as agriculture or environment. These include uncertainty about which stage of the policy process a HIA should be undertaken, deficiencies in the evidence base, lack of capacity, and difficulty embedding HIA in political and organizational culture. Methods to assemble the evidence to enable HIA to contribute to decision making are remain poorly developed [78].

The objective of this study was to develop the guideline practice for specific the roofing fiber cement industry. This paper described the formulation development and testing for a simple guide to reviewing evidence for use in HIA cement factory. The guide was designed to improve the way evidence is used by providing descriptive detail protocol for conducting or application to similar industry. The intervention was to make guideline into practices. The authors designed to support those carrying out both brief and comprehensive review in evidences of this industry. Finally, this study assessed whether the guideline enable users to distinguish evidence for HIA guideline into practice.

Methods

Study Designs and Settings

This study has been conducted in two phases. In first phase, the authors described the descriptive relevant reviews and concept basis for the study. The literature reviews were summarized the basic HIA concepts, HIA experiences from international and domestic contexts as well as the health risk assessment in roofing tiles fiber-cement manufacturing process and work environment. The developing HIA tools have been drafted according to 5 steps of generic HIA approaches, including screening, scoping, appraisal or assessment, reporting and reviewing, and monitoring and evaluation. This draft development and protocol have been determined according to health determinant domains such as environmental aspect, social and socioeconomic impacts, and health care services and provided feasibilities. Next, the first draft has been sent to experts for their suggestions and then making necessary changes through their critical appraisal and comments.

In second phase, the implementation and evaluation of HIA tools through pilot testing in fiber cement factory in both qualitative and quantitative measurements for quantifying the occupational exposure risks in the factory and community nearby, particularly health hazards. The appraisals of positive and negative impacts were included qualitative assessment through a walk-through survey, health risk rating and health risk matrix. The quantitative measurements were performed including respiratory health questionnaire interviews and physical health examination, self-health risk assessment, and health risk assessments (HRAs). HRAs were conducted through primary data source measurements such as personal and environmental samplings. Also, the secondary data assessments were accessed through health statistics and records of health statistic record using JHCIS program [63]. Finally, disseminate findings on occupational exposure risk impact assessment and HIA tools for determining the applicability to use in cement factory (Figure 4.5).

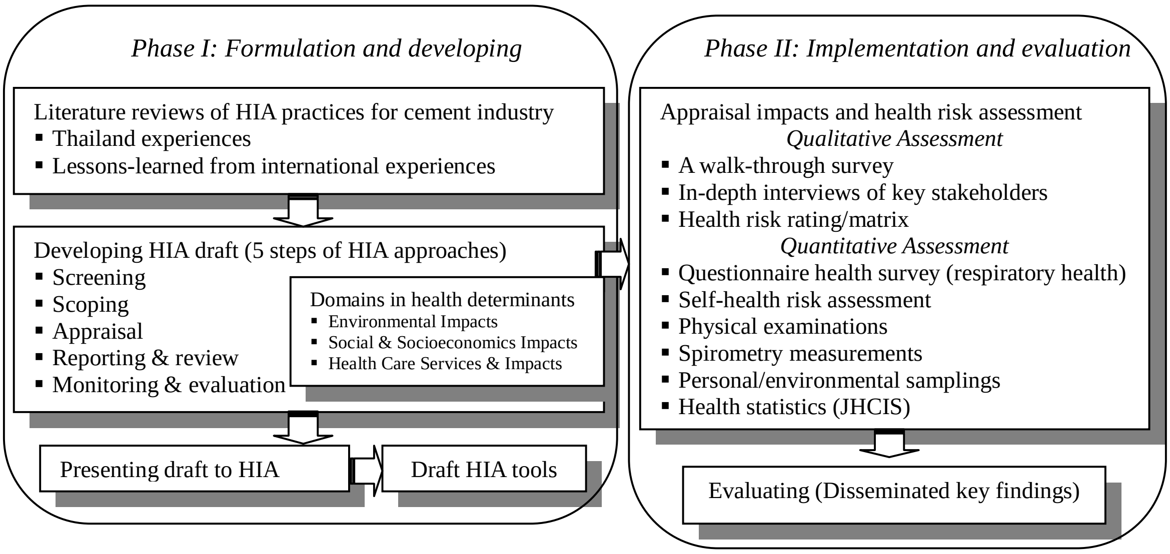


Figure 4.5: Box diagram for the development of a methodology for HIA in this study

Results

Phase I: formulation and developing

The draft HIA tools for roofing cement industry have been developed according to literature review specifically in Thailand. The overall acquired and necessary for HIA in EIA procedure have been summarized following the promulgated and compulsory enforcement in Thailand (Table 4.21). There are four main elements for HIA screening tool acquired including 1) scope and criteria 2) basic information acquires 3) characteristics and descriptive of the project and 4) health determinants. The criteria different compared with HIA in EIA procedure were included other relevant Act such as environmental protection laws.

In this study the questionnaire interviews have been employed for developing the HIA tools and guidelines for roofing fiber cement industry. The questionnaire survey has been sent to 5 experts from the university professors (n=2), MONRE representative (n=1), MOPH representative (n=1), and private organization representative (n=1). The results of survey were documented according to 5 main steps as assigned by the principal investigator as same as the previous literature review. Overall the experts' agreement on the draft of the screening HIA tools were summarized according to main elements including 1) scope and criteria 2) basic information acquires 3) characteristics and descriptive of the project and 4) health determinants(Table 4.21). The experts have allocated for weighing scale on HIA tool for roofing fiber cement industry as 20% for scope and criteria, 8% for basic information acquired, 22% for characteristics and descriptive of the project, and 50% for health determinants, respectively (Table 4.23).

Table 4.23: The draft screening HIA tool and descriptive characteristics for roofing cement industry

HIA screening criteria	Descriptive characteristics	Agreement [c]	Weighing scale (%) mean (max, min) [d]
1.HIA in EIA promulgation	1.1 The project/establishment is promulgated for conducting EIA [a]	✓	20 (25,15)
2.Scope and aims	2.1 Scope of the project	✓	8 (10,5)
	2.2 Objective of the project and scope of the report	✓	
	2.3 Rationale and significant of this project	✓	
	2.4 Scope and study methods	✓	
	2.5 Operational plan for establishments mechanic equipment	✓	
3. Descriptive characteristics of the project (Infrastructure and engineering layout, type and quantity of all materials used, public utilities, public facilities and desired servicing, and step of procedure of factory development or project lifecycle	3.1 Project type and location	✓	22 (30,10)
	3.2 Type and size of project	✓	
	3.3 Area utilization and layout	✓	
	3.4 Competency of productivity	✓	
	3.5 Manufacturing process	✓	
	3.6 Waste management	✓	
	3.7 Source of energy	✓	
	3.8 Water resources	✓	
	3.9 Materials used for construction	✓	
	3.10 Transportation (raw material and product)	✓	
	3.11 Electricity uses	✓	
	3.12 Water use	✓	
	3.13 Pre-construction phase	✓	
	3.14 Construction phase	✓	
	3.15 Management phase/operation phase	✓	
4. Health determinants and impacts	4.1 Toxic pollution and fate (construction phase/ operational phase)	✓	50 (60,40)
	4.2 HRA & Toxic assessment [b]	✓	
	4.3 Changing and impact to occupation and quality of life, etc.	✓	
	4.4 Impact on disability or under represent population	✓	
	4.5 Health care facilities and resources	✓	

[a] according to Ministry of Natural Resources and Environment according to environmental protection laws (Factory Act,1992, Hazardous Substance Act, 1992), Thai Constitution,2007 (article 67) and/ or National Health Act,2007 (article 11 & 25)

[b] HRA = Health risk assessment

[c] University professors (n=2); MONRE representative (n=1); MOPH representative (n=1); employee/private representative (n=1); MONRE = Ministry of Natural Resources and Environment; MOPH = Ministry of Public Health; HRA = Health risk assessment

[d] Allocation score and weighing scale (%)

The descriptive characteristics of acquired scoping were summarized according to 1) descriptive characteristics of the project, 2) health determinants and health effects (health hazards and risks, exposure and pathways, health impacts, health services), and 3) social impacts and quality of life (occupation and work environment and changing impact to relationship of population inside and outside the community)(Table 4.24).

The experts were agreed on the scope of HIA criteria for the roofing fiber cement industry according to 1) descriptive characteristics of the project such as infrastructure, working procedure, storage, and transportation of toxic waste required notification of quantity and waste management procedure, 2) health determinants including the natural changes and uses, for instance, health hazards and risks, exposure pathways and health care services, and 3) social impacts and quality of life such as changing and impact on occupation, work environment in changing impact to relationship of population inside and outside the community, changing in public area or cultural heritage area, and impact on disability or under represent population.

Table 4.24: The draft scoping HIA tool and descriptive characteristics for roofing cement industry

HIA scoping criteria	Descriptive characteristics	Agreement
1. Descriptive characteristics of the project		
1.1 Infrastructure and engineering layout	Type and quantity of all materials used and public utilities	✓
1.1 Production, storage, transportation of toxic waste	Required notification of quantity and waste management procedure	✓
1.2 Toxic pollution and fate from construction and production procedure	Data records and reports on waste, dust, noise, etc.	✓
2. Information of health determinants		
2.1 Health hazards and risks	Safety (machine, working environment, etc.) Physical hazards (noise, heat, etc.) Chemical hazards (cement dust, chromium compound (Cr III), hydrogen chloride, etc.) Biological hazard (molds) Ergonomics Psychosocial (work environment and emotional stress)	✓
2.2 Exposure pathways and contacts	Pathway and route of exposure (ingestion, inhalation, and dermal contact) Duration of exposure (frequency) Amount of exposure (level)	✓
2.3 Health impacts (end points)	Acute and chronic disease Accident and injuries Morbidity and mortality rate	✓
2.4 Health service system	Health care resources (hospitals, health centers, medical staffs, referral system and facilities) Health data statistics, records and baseline data	✓
3. Social impacts and quality of life		
3.1 Minority groups	Impacts on disability and under represent population	✓
3.2 Occupation and work environment	Occupational accidents and injuries, ecological changes, food supply, chain, and basic minimum needs	✓
3.3.Changing impact to relationship of population inside and outside the community	Labor migration, increase (decrease) public recreation areas in the community, and conflicting between populations	✓

In the appraisal process, the authors have been reviewed and evaluated based on health risk assessment and managing priority plan and management. The risk exposure assessment has been evaluated by hazard, homogeneous exposure group (HEGs), and working process and task. The risk rating matrix has been employed for calculating the potential health risks and their impacts.

According to preliminary study, the main health risk concerns at cement dust industry were respiratory health and diseases. There were two main groups of affected population including the employees and the population who are living nearby or surrounded the factory. The appraisal on exposure rating for the HIA tool for roofing fiber cement industry was summarized in table 4.25. The main criteria were classified into the matrix of exposure rating and levels of dust exposure.

Table 4.25: Descriptive characteristics of exposure rating scale for the appraisal HIA tool for roofing fiber cement factory

Exposure rating	Significant levels and definition	Description and criteria Affected populations	Health impacts	Employees	Health impacts
Level 1	Minimal risk	AQI[a] (0-50) or Toxic chemical < 10 % of standard level and/or exposure frequency 1-2 times/several year	No health impact	Toxic chemical < 10 % of standard level and exposure frequency 1-2 times/several year	No health impact or minimal
Level 2	Low risk	AQI (51-100) or Toxic chemical ~11-20 % of standard level and/or exposure frequency 2-3 times/ year	Low health impact for respiratory health	Toxic chemical ~11-50 % of standard level and exposure frequency 2-3 times/ year	Low health impact for respiratory health
Level 3	Moderate risk	AQI (101-200) or Toxic chemical ~21-30 % of standard level and/or exposure frequency 1-2 times/ month	Health impact to respiratory health of sensitive groups of exposure	Toxic chemical ~11-50 % and sometime 51-99% of standard level and/or exposure frequency 1-2 times/ month	Health impact to respiratory health of employees and require medication
Level 4	High risk	AQI (201-300) or Toxic chemical ~31-40 % of standard level and/or exposure frequency 1-2 times/ week	Health impact to respiratory health of sensitive groups of exposure and general population	Toxic chemical equal or above of standard level and/or exposure frequency 1-2 times/ week	Permanent
Level 5	Very high	AQI (>300) or Toxic chemical ~41-50 % of standard level and/or exposure frequency in every day	Health impact to respiratory health of sensitive groups of exposure and general population	Toxic chemical equal or above of standard level and/or exposure frequency in every day	Permanent/disability

[a]AQI =The air pollution concentration with standard air quality index (Department of Toxic Control); toxic chemical concentration compared with the standard level; exposure frequency

The health impacts on human risks have been characterized into two-dimension of health risk matrix of exposure rating and health effect rating. Health effect and exposure rating were determined and characterized based on health determinants. The exposure rating was determined according to no health impact, minimal risk, moderate risk, high risk, and very high risk whereas the health effect rating was classified into different levels. The score has been determined based on the degree of health impacts (Table 4.26).

Table 4.26: Descriptive characteristics of health risk matrix scale for the appraisal HIA tool for roofing cement industry

Exposure rating	Health effect rating				
	No health impact	Minimal	Moderate	High	Very High
Level 1	1	2	3	4	5
Level 2	2	4	6	8	10
Level 3	3	6	9	12	15
Level 4	4	8	12	16	20
Level 5	5	10	15	20	25

□ = No health impact; □ = Minimal; □ = Moderate; □= High; □= Very High

The rating health risk matrix has been quantified by scoring or scale on their potential health consequences (Tables 4.26). A rating or ranking is obtained by calculating the potential health consequence of each identified health hazard with the likely levels of exposures to it and by the likelihood of the hazard occurring or being present. Rating scale was modified from the International Council on Mining and Metals and International Standard Organization [21, 37].

The health risk assessments have been estimated by hazard, homogenous exposure group and by process, task then the potential health risks and the significance of those health risks categorized. The risk rating matrix is obtained by combination of the potential health consequence of identified health hazard of exposure levels and the likelihood of the hazard occurring. The quantitative measurements have been defined by numerical score as health risk matrix score (HRM_score) by the formula as below [86] (Table 4.27):

HRM_score = C*E*T*U

HRM_score	= Health risk matrix rating score
C	= Consequence of health impacts
E	= Exposure levels
T	= Duration of exposure
U	= Uncertainly

Table 4.27: Descriptive characteristics and definitions of health risk matrix rating score for the appraisal HIA tool for roofing fiber cement factory

HRM criteria	Rating scale Affected populations	 Employees
Consequence of health impacts (C)		
No health impact	1	1
Low health effects on respiratory health	5	5
Non-life threatening reversible health effects	10	10
Adverse health effects on respiratory health of sensitive groups of exposure and general population	20	40
Adverse health effects on respiratory health of groups of exposure and general population	40	80
Exposure levels(E)		
AQI[a] (0-50) or Toxic chemical < 10 % of standard level	1	1
AQI (51-100) or Toxic chemical ~11-20 % of standard level	2	4
AQI (101-200) or Toxic chemical ~21-30 % of standard level	4	8
AQI (201-300) or Toxic chemical ~31-40 % of standard level	8	16
AQI (>300) or Toxic chemical ~41-50 % of standard level	10	20
Duration of exposure(T)		
Exposure frequency 1-2 times/several year	0.5	1
Exposure frequency 2-3 times/ year	1	2
Exposure frequency 1-2 times/ month	2	4
Exposure frequency 1-2 times/ week	4	8
Exposure frequency in every day	10	20
Uncertainly(U)		
Certain	1	1
Uncertain	2	2
Very uncertain	3	3

[a]AQI =The air pollution concentration with standard air quality index (Department of Toxic Control); toxic chemical concentration compared with the standard level; exposure frequency
Rating scale was modified from the International Council on Mining and Metals and International Standard Organization [21, 37].

The average score has weighted into different levels of health matrix rating between health effects and exposure rating (Table 4.28).

Table 4.28: Descriptive characteristics and definitions of health risk matrix rating scale for the appraisal HIA tool for roofing fiber cement industry

Health risk matrix rating	Score	Classification of risk	Management and action plan
No health impact	Under 20	No any health risks	Require regular monitoring and assessment
Minimal	20-49	Acceptable risk without risk control and additional risk management	Require mitigation action/and or monitoring
Moderate	50-99	Acceptable risk with risk management and control for prevention any unexpected risks	Require mitigation as soon as possible
High	100-199	Unacceptable risk and required risk management and control for prevention any unexpected risks	Require immediate mitigation action with a program management and solution
Very High	200 and above	Unacceptable risk and urgently required risk management and control for prevention any unexpected risks or ceasing the project	Require immediate discontinuous/shutdown

Rating scale was modified from the International Council on Mining and Metals and International Standard Organization [21, 37].

The descriptive characteristics of HIA reporting, monitoring and evaluation criteria for roofing cement industry has been classified into two stages, including construction phase and operation phase (Table 4.29).

Table 4.29: Descriptive characteristics and definitions of the HIA reporting, monitoring and evaluation criteria for roofing cement industry

Main factors	Descriptive characteristics	Comments
Construction phase		
1. Air quality (dust, fume, etc.)	1.1 Covering sheet in car protecting falling raw material or objects	Vehicles and transportation
	1.2 Maintenance equipment for decreasing diesel exhausted	
	1.3 Cleaning automotive wheel get in and get out from the factory	
2. Noise	2.1 Limited construction time period	
	2.2 Maintenance equipment	
	2.3 Maintenance equipment with working plan and procedure	
3. Ground water quality	3.1 Mobile unit with septic tank	
	3.2 Septic waste management (BOD < 20 mg/l)	
4.Transportation	4.1 Limitation on speed of vehicle (< 60 km/hr)	
	4.2 Covering sheet of vehicle for carrying	
	4.3 Obey safety rule and regulations	
5. Water consumption	5.1 Supply clean water for employees	
6. Waste management	6.1 Provide garbage tank with lid	
7. Fire protection	7.1 Training employees on fire prevention and protection	
	7.2 Provide distinguish equipment	
	7.3 Obey safety rule and regulations	
8. Public health services	8.1 Provide environmental health and safety (drinking water, toilet, garbage)	
	8.2 Training employees on equipment use and safety, PPE use, etc.)	
	8.3 Restricted area and sign	
9. Occupational health and safety	9.1 Provide PPE (mask, helmet, gloves, glasses, shield protection, ear plugs)	
	9.2 Examine PPE*	
	9.3 Restricted area and safety sign use	
	9.4 Vehicle commuted system	
	9.5 Provide occupational hygienist or safety engineer	
	9.6 Examine the safety plan	

*PPE = personal protective equipment

Table 4.29: Descriptive characteristics and definitions of the HIA reporting, monitoring and evaluation criteria for roofing cement industry (cont.)

Main factors	Descriptive characteristics	Comments
Operation phase		
1. General management	1.1 SOP guideline for protection, prevention, mitigation and monitoring 1.2 SOP guideline for response and mitigation. 1.3 Accidental occurred and report to responsible agencies 1.4 Notify correction operation and working procedure	
2. Air quality (dust, fume, etc.)	2.1 Control air pollution under safety limits	Conducting personal and environmental samplings for total dust and respirable dust, CO, NO_2, and SO_2
3. Noise	3.1 Using ear plug 3.2 Working time limit 3.3 Regularly check noise levels 3.4 Noise-induced hearing loss examination 3.5 Noise control in production line 3.6 Using tree as a shield protection	
4. Water quality	4.1 Provide emergency pit 4.2 Provide septic tank 4.3 Chemical waste treatment and reduction (Cr+3) 4.4 Biological waste treatment 4.5 Sampling water quality in clean water pit 4.6 Physical sampling (pH, BOD, COD)	
5. Water release	5.1 Separate waste water treatment and ground water	
6. Waste management	6.1 Provide garbage tank with lid 6.2 Regularly report for chemical use and treatment	
7. Fire protection	7.1 Training employees on fire prevention and protection 7.2 Provide distinguish equipment 7.3 Obey safety rule and regulations	

Table 4.29: Descriptive characteristics and definitions of the HIA reporting, monitoring and evaluation criteria for roofing cement industry (cont.)

Main factors	Descriptive characteristics	Comments
8. Public health and occupational health and safety		Drinking water, toilet, garbage
	8.1 Provide environmental health and safety	
	8.2 Training employees on equipment use and safety, PPE use, etc.	
	8.3 Restricted area and sign	
	8.4 Provide PPE	Mask, helmet, gloves, glasses, shield protection, ear plugs
	8.5 Examine PPE	
	8.6 Restricted area and safety sign use	
	8.7 Vehicle commuted system	
	8.8 Provide occupational hygienist or safety engineer	
	8.9 Examine the safety plan	
	8.10 Fiscal physical examination	
	8.11 Surveillance and incorporate health statistics	
9. Social and economic aspects	9.1 Priority recruit employee with qualifications	
	9.2 Conduct operation plan with stakeholders	
	9.3 Provide public hearing and complaint	
	9.4 Support social cooperated responsibility project (education, public health, community services)	
	9.5 Community survey on attitude	
10. Recreation	1.10 Provide recreation area (10% area with green environment)	
11. Transportation	11.1 Safety rule for vehicle commute	

Phase II: implementation and evaluation

The authors involved in implementing and appraising following the outline of conceptual framework. The main implementation of this study was appraisal positive and negative health impacts. The study population, study design and measurements, and summary of the findings have been conducted. The results have been presented into two sections, including section 1: a walk-through survey was conducted presenting the investigation of occupational cement dust exposure and assessment of the health hazards (part 1) and personal and environmental dust samplings were conducted as well as the pulmonary function impairments were performed amongst them (part 2) and section 2: descriptive demographic and epidemiological and quantitative analysis of physical health impacts of the populations who are living near and far from the factory (part 1) and self-health risk assessment using quantitative measurements and semi-structured questionnaire interviews among the populations (part 2).

Section 1

Part 1

The investigation of occupational cement dust exposure and assessment of the health hazards in the roofing fiber cement processing industry were conducted with implications for identifying strategies for prevention. The total employees at roofing fiber cement were 122 workers. Most of them were males (n =110; 90 %). Only twelve female employees were employed and working in office. The mean age of employees was significantly different between both groups (32.33 years old for homogeneous exposure group or HEG1 and 36.16 years old for HEG2, respectively). Most of them had attained higher or college education (HEG1 = 100%; HEG2 = 97%). There was significantly higher duration of employment in HEG2 (8.93 years) than in HEG1 (5.75 years). More than 70% of both groups were working for more than 5 years. There were more than 57% of HEG1 (n= 34) and 66% of HEG2 (n= 41) who had never smoked. The current respirable dust (1.26; SD 0.98 mg/m^3) and cumulative respirable dust (3.03; SD

4.08 mg/m^3) were significantly higher in HEG1 than HEG2 (0.34; SD 0.63 mg/m^3 and 2.29; SD 3.65 mg/m^3).

Occupational safety risks to roofing fiber cement workers that were observed and characterized included mechanical hazards, dangerous working environment (wet floor, dimly lit areas), possible electrical accidents, excessive high heat and noise levels, high chemical exposure (total and respirable dust, iron oxide fume, chromium compound, and methyl ethylketone), poor ergonomics (work stations), and psychosocial and work stress related symptoms. The details of the study are provided elsewhere [78].

Part 2

Environmental risks and health hazards have been conducted in both personal and environmental dust samplings as well as the pulmonary function impairments were performed amongst them. The mean cement total dust exposure levels in the factory was 0.45(SD 0.28) mg/m^3 and respirable dust exposure levels was 0.61(SD 0.84) mg/m^3 under allowable dust exposure**.** The concentration of the total dust exposure was higher for the workers in depalleting and skid (n = 10, mean 0.72 (SD 0.30) mg/m^3, painting(n = 6, mean 0.67 (SD 0.35) mg/m^3 , water injection and curing (n = 12, mean 0.51 (SD 0.22) mg/m^3 than mixing and pulping(n = 14, mean 0.36 (SD 0.12) mg/m^3, storage(n = 8, mean 0.32 (SD 0.17) mg/m^3, and office(n = 8, mean 0.21 (SD 0.14) mg/m^3 ,respectively.

The lung function assessments were performed. The exposed group had a significantly higher prevalence than the unexposed group for shortness of breath (OR = 2.19; p = 0.02) and insignificantly higher prevalence than the unexposed group for chronic cough (OR = 1.34), chest tightness (OR = 1.64), and wheezing (OR = 1.89) after adjustment for age, duration of employment, pack years of smoking, and education.

The exposed group had a similar prevalence of normal pulmonary function (64%) compared with the unexposed group. The exposed group (32%) had a slightly higher amount of mild pulmonary impairment than the unexposed group (28%) whereas the unexposed group had a slightly higher amount of moderate pulmonary impairment than the exposed group. The high HEGs group(mixing and pulping, water injection, curing, de-pelleting and skid, spraying injection and painting) had insignificant slightly higher respirable cement dust exposure levels (0.617 mg/m^3) than the low HEGs group (quality control, storage and driving and maintenance) (0.607 mg/m^3) and the unexposed group (office and accessory; 0.397, mg/m^3) (p=0.056). The mean FVC, FEV1 and FEV1/FVC levels of the high HEGs exposed group were 87%, 86% and 87%, respectively, and those of the low HEGs exposed group were 85%, 88% and 90%, respectively, whereas those of unexposed group were 87%, 87%, and 88%, respectively (Table 11). The FVC (p=0.84), FEV (p=0.79) and FEV1/FVC (p=0.17) levels were insignificantly different among the high HEGs and low HEGs groups as compared with the unexposed group. Full details of the quantitative research study are provided elsewhere [63].

Section 2

Part 1

At the cement factory is located, there were totally 6,746 populations (male = 3,220; female=3,376). The health data registries were endorsed and extracted from two responded Health Centers. According to Kongsoa Health Center (KHC), there were totally 2,140 populations who are living nearby the factory within 2-km in radius whereas 4,606 populations who are living far (Kaewsaen Health Center; KSC) from the factory at 5-km in radius (Table 4.30).

Table 4.30: Number and prevalence of 6-leading outpatient according to JHCIS database of Kongsoa Health Center and Kaewsaen Health Center, 2009-2011

Diseases	Kongsoa HC (n= 6,530 [a])		Kaewsaen HC (n= 13,584 [a])	
	No.	Rate per 1,000	No.	Rate per 1,000
1. Respiratory system	1,311	200.77	2,374	174.76
2. Digestive system	659	100.92	1,034	76.12
3. Cardiovascular disease	653	100.00	1,090	80.24
4. Skin disease and coetaneous	446	68.30	418	30.77
5. Musculoskeletal	420	64.32	532	39.16
6. Hypertension	182	27.87	317	23.34

JHCIS = the use of graphic user interface according to data record of MOPH by 18 folders

[a] A number of total populations summed up of 3 years, 2009-2011

Part 2

Ninety six participants of near and 101 subjects of far group were participated in this study. The mean age of near group was insignificantly lower than far group with 38.8 years old on average compared to 42.6 years old. The ratio of male to female was significantly different between both groups ($p = 0.011$) by response rate of male in near group was lower than far group. There were insignificantly different in marital status ($p = 0.140$), educational levels ($p = 0.588$), and occupations ($p = 0.883$) between both groups. The majority of participants were married (70%) and agriculturist (72%) in both groups.

In cumulative rating for self-HRA of each health determinants, the near population group (30.34%) had significantly higher positive rating in mental assessment than far population group (10.59%)(p <0.001) whereas they had lower rating on negative impacts (14.61% vs 38.82%), respectively. Similar to mental assessment, the near population group had significantly higher positive rating in social health impacts (28.42%) than far population group in social aspects (16.67%) whereas they had significantly lower negative rating in social aspects 9.47% vs 32.22%. The near population group (29.79%) had a similar positive rating in spiritual health impacts compared with far population group (27.08%), but the near population group (7.45%) had lower negative rating in spiritual health impacts than for far population group (29.17%). The details of the quantitative and qualitative research study are provided elsewhere [18].

According the quantitative measurement on HRA, the health risk matrix score were determined. The affected populations in near group (score = 20) have HRM score slightly higher than far group (score = 10), but the employees have higher than affected populations (score = 40). Consequence of health impacts was derived from the results in section 1 and section 2 of health statistics and respiratory health examinations and spirometry measurements. Exposure levels were conducted in both personal and environmental samplings (Table 4.31).

Table 4.31: Descriptive characteristics and definitions of health risk matrix rating score for the appraisal HIA tool for roofing fiber cement industry

HRM criteria	Rating scale: Affected populations	Rating scale: Employees	HRM_score: Affected populations Near	HRM_score: Affected populations Far	HRM_score: Employees
Consequence of health impacts (C) [a]					
No health impact	1	1			
Low health effects on respiratory health	5	5	✓	✓	✓
Non-life threatening reversible health effects	10	10			
Adverse health effects on respiratory health of sensitive groups of exposure and general population	20	40			
Adverse health effects on respiratory health of groups of exposure and general population	40	80			
Exposure levels(E) [b]					
AQI[a] (0-50) or Toxic chemical < 10 % of standard level	1	1	✓	✓	✓
AQI (51-100) or Toxic chemical ~11-20 % of standard level	2	4			
AQI (101-200) or Toxic chemical ~21-30 % of standard level	4	8			
AQI (201-300) or Toxic chemical ~31-40 % of standard level	8	16			
AQI (>300) or Toxic chemical ~41-50 % of standard level	10	20			
Duration of exposure(T)					
Exposure frequency 1-2 times/several year	0.5	1			
Exposure frequency 2-3 times/ year	1	2			
Exposure frequency 1-2 times/ month	2	4	✓	✓	✓
Exposure frequency 1-2 times/ week	4	8			
Exposure frequency in every day	10	20			
Uncertainly(U)					
Certain	1	1		✓	
Uncertain	2	2	✓		✓
Very uncertain	3	3			
Total score			20	10	40

[a] Consequence of health impacts was derived from section 1 and section 2

[b] Results were based on personal and environmental samplings

Discussion and conclusions

This was the first study designed to apply the HIA framework in order to assess the health impacts of the roofing fiber cement industry in Thailand. This study integrated evidence from exposure reviews of cement dust and intervention studies to reduce dust exposure in the field. This study was also explored the gaps found in the two main types of HIA conducted in Thailand, HIA for healthy public policy and HIA in EIA legislation under the MONRE. The recommendations, limitations and needs to advance HIA tool development in cement industry were presented (Chapter V).

Though it is not required that a HIA needs to be conducted in the roofing fiber cement factory is under MONRE, a HIA can be performed in this setting under the Thai Constitution Act (2007) and National Health Act (2007) as well as the previously enacted environment laws such as Environmental Promotion and Conservation Act (1992), Factory Act (1992), Hazardous Materials Act (1992) and Public Health Act (1992). Therefore, the affected populations and key stakeholders have the right to propose that a HIA should be conducted for a project or activity in their community that to investigate and prevent suspected hazards and health risks.

According to the literature reviews , the implementation of HEIA still faces many obstacles, especially in such complex policy sectors and several key players were involved. The uncertainties, lacks of evidence base, difficulty to implement HEIA in political and cultural contexts are contributed to decision making and remain developed. The specific HIA tools and methodologies for implementing in roofing fiber cement industry were obscured. The existing HIA tools and methods could be tested in other factories and compared the results. The future study may apply a well designed of HIA tools and methods from other countries such as good practice guidance on HIA of mining and metal project [86].

The available data at local levels should be integrated and connected such as development of program high performance application for hospital (HOSxP) database for electronic health care database, health surveillance database for disease statistics from disease surveillance system (e.g., communicable disease, non- communicable disease, suicide and injury), and air quality management by Pollution Control Department. However, presently the JHCIS program will be upgraded and transformed connecting the HOSxP database. Therefore, the data available in Health Centers were linked and compatible with database in community hospitals. It would be more robust to consensus on high value of HIA database and need for substantial resources to build and maintain it. Building and maintaining database that include inventory of HIA tools were held to determine such a specific health impacts of changes. However, local health disparity data may not be available.

This study suggested that the HIA conducting should be initially starting with preparation stage as a pre-step for gathering important data and resources as well as the experts or the advisory committee should be stepped in. The key stakeholders and affected populations will need extra time to prepare and process information beforehand since a number of previous projects lacked of providing enough detail information about the projects and population engagement. Therefore, the practical guideline for conducting HIA should sequentially consist of initial preparing, screening, scoping, appraisal, reporting and reviewing and monitoring and evaluation (Figure 4.6). Then the screening tool is employed for deciding what level of HIA is required such as rapid or comprehensive health impact assessment. From the applications of self-health risk tool assessment, this study found an association between self-HRA of positive mental, social, and spiritual impacts of the cement factory could be reflect to the risk perceptions the affected community and living in the vicinity of the roofing fiber cement factory. One conclusion of this study is that those who lived near the factory felt that they had greater social and economic benefits from the factory compared to those living far away from the factory. In addition, those living near the factory did not seem more concerned about environmental health risks of the factory than those living far away from the factory.

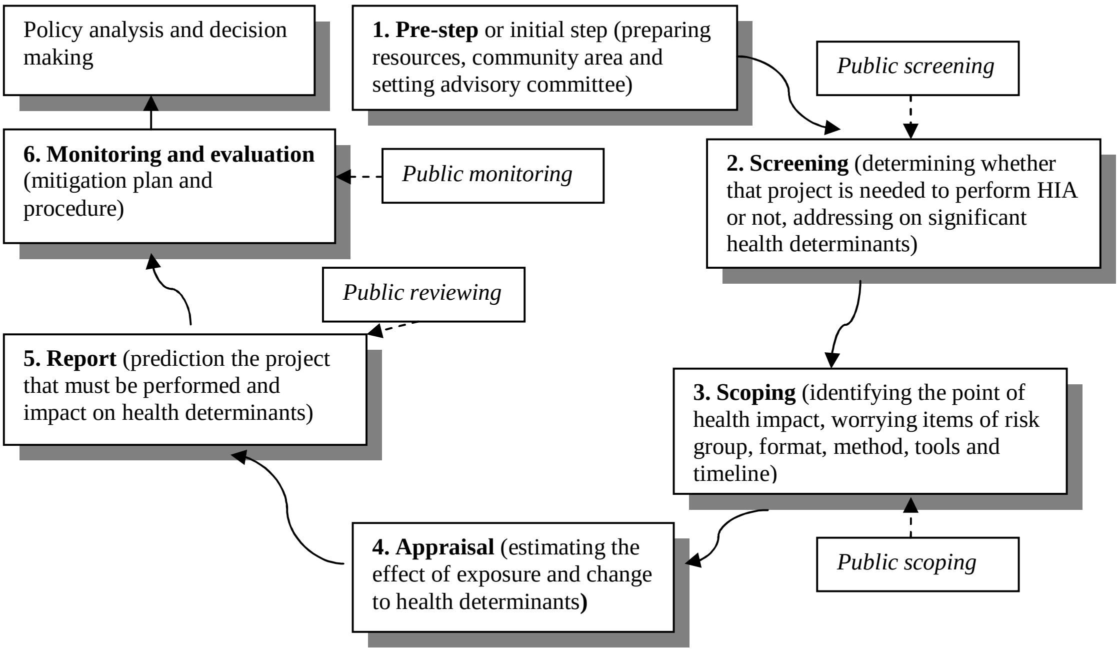


Figure 4.6: Logical framework for conducting HIA

Importantly, the context of HIA applications and policy involvement should involve participation by stakeholders and affected populations for the HIA in different stages at the beginning at pre-step for preparing resources and community area. The stakeholders can participate at the screening process as public screening for determining whether that project is needed to perform HIA. Also, the public scoping for identifying the health impacts, worrying issues of risks and method that used to conduct HIA as well as the timeline are also included. In the public reviewing, the populations can examine the report that was conducted HIA on health determinants. Lastly, it is recommended for the populations and stakeholders to participate in monitoring and evaluation the project in construction and operation phase. Developing incentives for HIA use, such as involving decision makers in HIA process, promoting HIA as part of improved policymaking, and motivating communities to ask for HIA process were advantages for HIA development in cement industry.

The committees could include the steering and working group. The group members should be multidisciplinary experts and key stakeholders such as the industry owner, the manager, EIA consultant firms, health care providers and professional, community leaders, and affected populations. However, it is required more resources and costs and time-consuming for conducting HIA.

Based on quantitative measurements on HRA, the affected populations in near group and far group had slightly lower health risks from the cement factory than the employees. The recommendations for protecting and promoting them required regular mitigation and monitoring according to regulations that will be warranted for their safety.

The scoping criteria have been evaluated as the term of reference (TOR) for cement factory. The experts agreed on main pillars for conducting the HIA, including health determinants and health effects, working procedures and management, toxic pollution and fate, occupational and work environment, community involvement and impacts, and health care facilities and services.

The appraisal for HIA in fiber cement factory could employ systemic determining of potential impacts that is likelihood. This study employed the impacts on human risks into two-dimension of health risk matrix of exposure rating and health effect rating. Health effect and exposure rating were determined and characterized based on health determinants. The appraisal of health impacts involves systematically determining the range of potential impacts that is likely to be occurred. The key findings and recommendations of an HIA have been presented in a written report as a public document for providing decision making. The report described the HIA methods used, key findings, and the recommendations for enhancing and mitigating potential health impacts. Finally, the monitoring and evaluation has been determined based on the impacts identified, public health significance and the priority attributed by the affected populations. The follow-up activities have been proposed of health management plan including the monitoring the health impacts of both actual and predicted impacts. In the stage of construction and operation phases, the stakeholders and affected populations could have opportunities to request their complaint and the responsible person or project manager or factory manager can create the system that respond to their complaint (Figure 4.7)

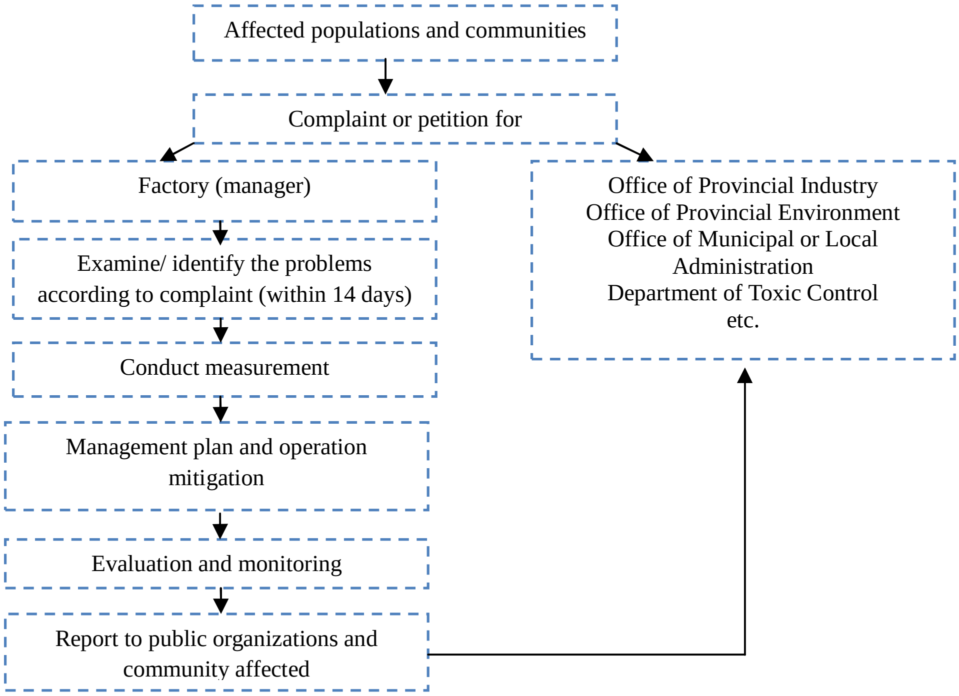


Figure 4.7: scheme of complaint and response

There is a need to build human resource capacities for implementing HEIA such as trained HIA experts and staffs. Public health officials need some additional training to conduct HIAs since public health officials presenting HIA results need to be credible and knowledgeable to influence decision makers. Therefore, it is important to train multidisciplinary teams in HIA skills and educate community stakeholders about HIA process to increase HIA capacity and usefulness. In addition, the HIA practitioners should be trained in skills for community involvement such cultural sensitivity and accountable listening.

CHAPTER V
DISCUSSION

This chapter presents general discussion of the findings, limitations of the study, and conclusion, implication, and future research needs. The outline of discussion is focused on the outputs and key findings of the study. This study did not analyze the economic costs and benefits. Economic analysis may be an influential in decision making and cost-effectiveness can be used for mitigation option. More details of the quantitative and qualitative research, discussion and limitations of this study were presented in Chapter IV.

This was the first study aimed to implement and test whether HIA is suitable for the roofing fiber cement industry. This study used of evidence in HIA, integrating the evidence of exposure reviews and conducting an intervention in the field. It is not required for HIA in EIA for roofing fiber cement factory. However, a HIA for this factory can be performed in this setting under the Thai Constitution Act (2007) and National Health Act (2007) as well as the previously enacted environment laws. The populations and key stakeholders have the right to conduct and investigate suspected hazards and health risks from the production processes and waste management.

The objective of this study was to develop health impact assessment tools (HIA) specific to the roofing fiber cement industry. This study has been conducted in two phases. The first phase is a descriptive review and basis of the study. The second phase is the implementation and evaluation of HIA tools through pilot testing in a fiber cement factory. The developed HIA tools were drafted according to the 5 steps of HIA approaches including: screening, scoping, appraisal or assessment, reporting and reviewing, and monitoring and evaluation. The implementation and evaluation of HIA tools was conducted through pilot testing in a fiber cement factory. Both qualitative and quantitative measurements were used for assessing the occupational exposure risks in the factory and the community nearby.

A cross-sectional study was utilized. Environmental samplings and spirometry measurements were also collected. An application of self-health risk assessment among populations living in the vicinity of a fiber-cement roofing factory was also conducted. The secondary data assessments were conducted through health statistics and records of health statistic record using the JHCIS program. Finally, findings on occupational exposure risk impact assessment and the applicability of HIA tools in a cement factory were disseminated and concluded.

Determining occupational risks and health hazards at roofing cement processing were conducted through a walk-through survey as well as environmental and personal dust samplings measurements were performed according to similar homogenous exposure groups (HEGs)**.** The records of physical exams and environmental samplings were also reviewed. The concentrations of the total dust exposure were higher for the workers at depalleting and skid (0.72 ± 0.30 mg/m^3) and painting and spraying (0.67 ± 0.35 mg/m^3). The respirable dust levels were higher for the workers in painting and spraying (1.18 ± 0.87 mg/m^3). The noise exposure levels at mixing and pulping were higher than OELs. The heat exposures were high at racking and curing department (32-34ºC) and de-palleting and skid (32-33ºC). Chemical hazards were detected, including HCl(0.021-0.067 mg/m^3) , Cr (III) (0.001 mg/m^3) and Fe_2O_3 (0.008 mg/m^3) at painting and spraying. Over half were rarely used mask protection (58%) for higher HEG (HEG2) whereas almost 44% for lower HEG (HEG1). This study suggested that workers should use personal protective equipment such as mask, ear plugs and education and training programs to ensure adequate precautions and concerns to protect workers' health.

Occupational health risk assessment on respiratory symptoms and patterns of pulmonary dysfunction among workers were performed and compared with lower exposure in employees (e.g., office employees, subcontract workers) and nearby populations. One hundred and fifteen exposed workers and 134 unexposed subjects were included in this study. The exposed workers had higher respiratory dust exposure levels (0.65 mg/m^3) compared with the unexposed groups (0.32 mg/m^3). The exposed group had significantly higher prevalence than the unexposed group for shortness of breath (OR =

2.19). The exposed group also had higher but insignificant prevalence of chronic cough (OR = 1.34), chest tightness (OR = 1.64), and wheezing (OR = 1.89). The ventilatory respiratory function values (FEV1 and FVC) were slightly lower for the exposed group. An association between higher cement dust levels and a decline in ventilatory function among roofing fiber cement workers suggests that the respiratory health of roofing cement workers should be protected through policies or work standards.

The self-health risk assessment (HRA) among populations living in the vicinity of a fiber-cement roofing factory was conducted to verify which aspects are related to population health outcomes. This study has demonstrated that the 2-km population group (30.34%) had significantly higher positive ratings for mental assessment than 5-km population group; conversely,(10.59%) ($p < 0.001$) the 2-km group had lower ratings on negative impacts (14.61% vs 38.82%), respectively. The near population group had significantly higher positive rating in social health impacts (28.42%) than far population group in social aspects (16.67%). The near population group (29.79%) similarly had a higher positive rating in spiritual health impacts compared with the far population group (27.08%). In addition, the near population group (7.45%) had lower negative rating in spiritual health impacts than far population group (29.17%). However, there were no significant different among male populations in all aspects. In conclusion, an association between self-HRA of positive mental, social, and spiritual could be affect risk perceptions of populations in the affected community and living in the vicinity of the roofing fiber cement factory. Our findings contribute to previous knowledge on self-HRA for HIA development procedure. The main implication of this study relies on the effect of living proximity on their awareness and concerns for health risk exposures from the surround environment.

Improving the use of evidence in the health impact assessment for the roofing fiber cement industry was employed HIA protocols and explored the capabilities for purposive utilizations as a model development. In this study, the screening tools focused on risks and impacts on human health based on specific health determinants. Percentage values were categorized into five groups as follows: minimal health risk, low, moderate, high, and very high impacts on human health. The appraisal for HIA in fiber cement factories could lead to the employment of systematic determination of potential health impacts. This study employed the impacts on human risks into two-dimensions: health risk matrix of exposure rating and health effect rating. The health risk matrix score (HRM) was determined through the quantitative measurements on the health risk assessment. The affected populations in the near group (score = 20) have a HRM score slightly higher than the far group (score = 10), but the employees had a higher HRM score (score = 40) than both of the affected populations. In conclusion, the application of the health risk matrix rating score as a HIA tool for roofing fiber cement factories could be employed for quantitative risk assessment. However, further study is warranted. This study suggested that the HIA conducting should be initially started with a preparation stage to gather important data and resources. Experts and/or the advisory committee should also step in at this stage. Stakeholders and affected populations should be involved in all stages from the pre-step through the monitoring and evaluation stages.

Implications, Limitations and Future Research

The future development on a quantitative HIA-tool for EHIA or healthy public policy could be compared two or more policy options and quantified the differences in the projected health impacts and outcomes. There are three main steps to address 1) description of the baseline situation and health information database in the community. The improvement of database records in terms validity and reliability of and accessibilities from different sources is crucial for quantitative measurement in HRM_score , 2) estimation of change in exposure to determinants of health. The exploration in health determinants and health risk matrix incorporated with risk rating are contributed in HIA quantifications for cement factory, and 3) calculation estimated changes in health outcomes. The improvised HRM equation for further research has advantages for HIA tool development. The outline for developing quantitative HIA-tool should consist of 1) the tool has to be publicly accessible and available. The HIA tool should be open to review widely by academics and stakeholders. The suggestions from them will be benefits for improving and revising the model, 2) the tool should be based on evidence data conducting epidemiological database or using available secondary existing database such as HOSxP database. However, the tool is limited by existing data available and validity and reliability of data inputs, and 3) the tool should be able to present the changes in population health over time simulation and dynamic responses. It should be flexible for operations. For example, it should be possible to calculate different diseases with varying risk factors. The tool should be applied with logic to reach its valid conclusions. The HIA tool can be used for local organizations and communities as community HIA (CHIA). The process should be linked to customs, traditions, and the ways of life and beliefs of local communities (Table 5.1).

Table 5.1: Recommendations and needs to advance HIA tool development in cement industry

Items	Recommendations
Existing HIA tools and methods HIA measures and HIA resource database	• Conduct HIA pilot tests in other factories and compare the results. • Integrate or apply a well design of HIA tools and methods from other countries. • Use existing tools and databases (e.g., governmental database systems—MOPH HOSxP & JHCIS, Department of Pollution Control). • Consensus on high value of HIA database and need for substantial resources to build and maintain it. • Improve quantification of effects of changes in health determinants, such as specific health impacts of changes. • Build and maintain database that includes inventory of HIA tools, guide to choice of HIA tools. • Local health disparities data may not be available.
Context for HIA applications and policies involvement	• Identify HIA methods best suited for evaluating specific types of cement projects. • Develop social strategy for improved visibility of public health and populations. • Participate by involved stakeholders and affected populations and have shorter time frame. •The HIA tool can be used for local organizations and communities as community HIA (CHIA).
HIA community involvement and environmental justice	•Consolidate HIAs as regulatory process to ensure legitimacy and build constituency and existing EIA laws and related laws (public health and environment act). • Increase the possible project types promulgated EHIA. • Community involvement promotes environmental justice and social equity, helps identify local relevant issues, aids community empowerment, and improves transparency of decision making. • Develop guidelines and identify best practices to facilitate community involvement. • Train HIA practitioners in skills for community involvement such as cultural sensitivity and accountable listening. • Participants in HIA process and interactions with decision makers vary by organization and topic. • HIA best done as early as practical in decision process during window of opportunity for usefulness. •Self-HRA in vicinity of the factory
Increasing HIA specialists and training public health professionals in HIAs	• Explore potential for various groups to take lead on conducting HIAs, such as health officers, academics, and consultants. • Train multidisciplinary teams in HIA skills. • Public health officials need some additional training to conduct HIAs. •Adapt existing and develop new HIA training resources for use in Thailand (e.g., guides, courses, and web sites, case studies, core curriculum, distance learning). • Educate community stakeholders about HIA process to increase HIA usefulness. • HIA experts and planners can use HIA to educate public health officials about constraints in planning.

Table 5.1: Recommendations and needs to advance HIA tool development in cement industry (cont.)

Items	Recommendations
Training planners and decision makers in HIAs	• Develop incentives for HIA use, such as involving decision makers in HIA process, promoting HIA as part of improved policymaking, and motivating communities to ask for HIA process. •Develop briefings, seminars, short courses, and case studies about HIA for planners and decision makers. • Create media attention to HIA process.
Evaluation of HIAs	• Major forms are process evaluation of HIA steps done, impact evaluation of effect of HIA on project or policy, and outcome evaluation of actual health impacts compared with those predicted. • Useful to evaluate stakeholder involvement. • Some HIA evaluations have been completed, but comparisons of HIAs are difficult because of variability in reporting. • Review and conduct further HIA evaluations. • Develop practical criteria for process, impact, and outcome evaluations of HIAs. • Develop staff capacity to conduct evaluations of HIAs. • It is recommended the key stakeholders and affected populations should participate in different HIA steps using community participatory approaches including social/holistic methods; range from checklists to multistep processes
Communicating findings of HIAs	• Potential audiences include planners, politicians, project developers, health agencies, media, community stakeholders, and academics. • Nontechnical report, needed for political decision makers, community stakeholders, and lay audiences, should include background, health impact findings, and recommendations. • Report for technically trained audience should include executive summary, scoping, literature review, assumptions, and major health impact findings, and sensitivity analyses, levels of uncertainty, discrepant views, and recommendations. • Develop guidelines for HIA reporting formats to facilitate later comparisons and evaluation • Create model HIA reports that can be used to educate decision makers about HIAs
Resource needs and limitations of HIAs	• Need trained staff, time, and other resources to do HIAs. • Demand for HIA affected by political context and severity of health outcomes of project or policy. • Need political support and public and non-public organizational alliances to build support for HIAs. • Improve communication tools to inform decision makers about HIAs. • Develop guidelines for selecting appropriate HIA tool based on context and resources available. • HIAs of policies may have broader scope of potential impacts, take more time, affect more people, involve more stakeholders, and be more complex. • Private sector plays more of role in project development in United States than in Europe. • Examine how HIA achieved current levels of support and legitimacy in Thailand environmental contexts. • Barriers to adding HIA to existing regulatory EIA processes include adequacy of HIA predictions in litigious EIA environment, political and legal challenges to changing EIA practices, and need for resources. •Economic assessment

Robust and quantitative measurement tools for HIA in cement factory

This study was simplify the quantitative measurements and employed quantitative measurement for estimating relative risks among affected populations and employees at cement factory, using HRM_score. The improvement for robust and quantitative HIA equation can be ideally proposed for future study to consolidate the health impacts according to 1) evidence of the effects, 2) a causal pathway construction, 3) calculation the impacts and application of mathematical modeling on affected populations and employees at cement factory.

Evidence of the effects

After conducting exposure assessment and field samplings (i.e., personal and environmental samplings, physical exams and lab tests, etc.), each of variables is calculated under equation assumptions. The systematic reviews of each variable are based previously evidences and studies. The consequence of health impact(C) can be appraised based on the health burden and main health outcomes due to identified occupational hazards and risks such as cement dust levels, chemical exposure levels (HCl, Cr (III), Fe2O3). Exposure levels (E) are identified according the field sampling and inventory records. The duration of exposure (T) is measured for duration of employment and work shift daily basis. The uncertainty (U) of effects could simplify using existing modeling adjustment.

A causal pathway construction

The diagram of procedure and pathway exposure for cement factory can be helpful to map the causal pathways by which health impacts are expected to occur. The linkages between the factory and its potential health impacts such as respiratory symptoms and diseases can help to ensure that the analysis can be linked to evidence and considers interactions between various impacts. It can also inform the recommendations by helping to identify points along the causal pathways where interventions could maximize the potential positive impacts and minimize the potential negative impacts in cement factory.

Calculation the impacts and mathematical modeling

To quantify the health impacts among employees and populations for cement factory, the conceptual model is visualize for health impacts. The model will represent the casual pathway in a way that allows each step to be quantified and integrated different data. The environmental risk model is included exposure to hazards, dose-response relationship and health outcomes, and the casual pathway of hazards. This could also form a basis for statistical modeling of the effects on health determinants of policy proposals by deriving the population exposure distribution and specify the time window between exposure and effect. Its model is a real life population, dynamic, and projects reference and intervention scenario over time. It should provide the output and has a graphical user interface that needs no programming or advanced computing skills, and allows general accessibility.

REFERENCES

[1] Phoolcharoen, W., Sukkumnoed, D., Kessomboon, P. Development of health impact assessment in Thailand: recent experiences and challenges. Bulletin of WHO 81 (2003): 465-467.

[2] National Health Commission Office. Thailand Thailand's Rules and Procedures for the Health Impact Assessment of Public Policies. [Online]. 2010. Available from: http://www.nationalhealth.or.th [2011, May 15]

[3] Jindawattana, A., Sukkumnoed, D., Pengkam, S., Chuenchit, W., Mathurapote, W. HIA for HPP towards healthy nation: Thailand's recent experienced. National Health Commission Office (2008).

[4] Office of Natural Resources and Environmental Policy and Planning (ONEP) Guideline for Environmental Impact Assessment in Thailand. [Online]. 2010. Available from: http://www.onep.go.th [2011, May 15]

[5] Stanek, L.W., Brown, J.S., Stanek, J., Gift, J., Costa, D.L. Air pollution toxicology a brief review of the role of the science in shaping the current understanding of air pollution health risks. Toxicol Sci. 120 (2011):Suppl 1:S8-27.

[6] Logue, J.M., Price, P.N., Sherman, M.H., Singer, B.C. residences. Environ Health Perspect. 120(2012) :216-22.

[7] Vichit-Vadakan, N., Vajanapoom, N. Health impact from air pollution in Thailand: current and future challenges. Environ Health Perspect. 119 (2011):A197-8.

[8] Mwaiselage, J., Bråtveit, M., Moen, B., Mashalla, Y. Respiratory symptoms and chronic obstructive pulmonary disease among cement factory workers. Scand J Work Environ Health. 31(2005):316-23.

[9] Al Neaimi, Y.I., Gomes, J., Lioyd, O. Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. Occup Med. 51(2001):31-45.

[10] Noor, H., Yap, C.L., , O., Faridah, M. Effect of exposure to dust on lung function of cement factory workers. Med J Malaysia 55(2000): 51-57.

[11] Zeleke, Z.K., Moen, B.E., Braviet, M. Cement dust exposure and acute lung function: a cross shift study. BMC Pulmonary Medicine. (2010): 10-19.

[12] Zeleke, Z.K., Moen, B.E., Braviet, M. Lung function reduction and chronic respiratory symptoms among workers in the cement industry: a follow up study. BMC Pulmonary Medicine. 11 (2011) : 45-50.

[13] Neghab, M., Choobineh, A. Work related respiratory symptoms and ventilatory disorders among employees of a cement industry in Shiraz, Iran. . J Occp Health. 49(2007):273-278.

[14] Yang, C.Y., Huang, C.C., Chiu, H.F., Chiu, J.F., Lan, S.J., Ko, Y.C. Effects of occupational dust exposure on respiratory health of portland cement workers. J Tox Environ Health. 49(1996):581-588.

[15] Mwaiselage, J., Bråtveit, M., Moen, B., Mashalla, Y. Cement dust exposure and ventilatory function impairment: an exposure-response study. J Occup Environ Med. 46(2004): 658-67.

[16] Nordby, K.C., Fel, A.K., Noto, H., Eduard, W., Skogstad, M., Thomassen, Y., et al. Exposure to thoracic dust, airway symptoms and lung function in cement production workers. . Eur Respir J. 38(2011):1278-86.

[17] Fell, A.K., Thomassen, T.R., Kristensen, P., Egeland, T., Kongerud, J. Respiratory symptoms and ventilatory function in workers exposed to Portland cement dust. J Occup Environ Med. 45(2003) :1008-14.

[18] Abrons, H.L., Petersen, M.R., Standerson, W.T., Engelberg, H.P. Symptoms, ventilator function, and environmental exposures in Portland cement workers. British J Indus Med. 45(1998): 368-375.

[19] Fell, A.K., Sikkedland, L.I., Svendsen, M.V., Kongerud, J. Airway inflammation in cement production workers. J Occup Environ Med. 67(2010):395-400.

[20] Alli, B. Fundamental principles of occupational health and safety. International Labor Organization (2001).

[21] International Organizational for Standardization (ISO) [Online]. 2011. Available from: http://www.iso.org/iso/home.html [2011, July 10]

[22] Canadian Handbook on Health Impact Assessment: Volume 1: The Basics Accessed [Online]. 2011 Available from: http://dsp-psd.pwgsc.gc.ca/Collection/H46-2-04-343E.pdf [2011, August 30]

[23] IMPACT assessment project University of Liverpool Accessed September 30, 2011 http://www.liv.ac.uk/ihia/IMPACT_HIA_Reports.htm

[24] Harris, P., Harris-Roxas, B., Harris, E., Kemp, L. Health Impact Assessment: A Practical Guide.(2007)

[25] Veerman, J.L., Barendregt, J.J., Mackenbach, J.P. Quantitative health impact assessment: current practice and future direction. J Epidemiolol Community Health 59(2005): 361-370.

[26] Davenport, C., Mathers, J., Parry, J. Use of health impact assessment in cooperating health considerations in decision making. J Epidemiolol Community Health 60 (2006) :196-201.

[27] Mcintyre, L., Pettcicrew, M., Methods of health impact assessment: a literature review.(1999).

[28] World Health Organization (WHO). Glossary of terms used in Health Impact Assessment. [Online]. 2010. Available from: www.who.int/hia/about/glos/en/index.html. [2011, September 10];

[29] The Thoracic Society of Thailand. [Online]. 2010. Available from: http://www.thaithoracic.or.th/knowledge/download/GuidelinePFT.pdf. [2010, April 10].

[30] NIOSH Manual of Analytical Methods (NMAM), Fourth Edition [Online]. 2003. Available from: http://www.cdc.gov/niosh/docs/2003-154/ [2010, April 10].

[31] Oss, H.G. and Padovani, A.C. Cement manufacture and the environment part II: environmental challenges and opportunities. J Indus Ecology.1(2003):93-118

[32] World Health Organization (WHO). Health impact assessment [Online]. 2011. Available from: http://www.who.int/hia/en/ [2011, August 30]

[33] National of Assembly for Wales. 2010 Developing Health Impact Assessment in Wales [Online]. 2011. Available from: http://www.assemblywales.org/ [2011, August 30]

[34] U.S. Environmental Protection Agency [Online]. 2011. Available from: http://www.epa.gov/ [2011, August 30]

[35] Scott-Samuel, A., O'Keefe, E., Health impact assessment, human rights and global public policy: a critical appraisal. Bulletin WHO. 85(2007): 212-217.

[36] Bisesi, M.S. Industrial hygiene evaluation methods. Lewis Pub. (2003).

[37] The International Council on Mining and Metals (ICMM). Good Practice Guidance on Health Impact Assessment [Online]. 2011. Available from: http://www.icmm.com [2011, August 30]

[38] Thailand Industrial Standard Institute (TISI) [Online]. 2011. Available from: http://www.tisi.go.th/ [2011, August 30]

[39] Mannheimer, L.N., Gulis, G., Lehto, J., Ostlin, P. Introducing Health Impact Assessment: an Analysis of Political and Administrative Intersectoral Working Methods. European J Public Health. 17(2007): 526-531

[40] Wisma, M., Blau, S., Earnst, K., Figueras, J. The effectiveness of health impact assessment in Europe: Scope and limitations of supporting decision-making in Europe. The Cromwell Press, UK. (2007).

[41] Petticrew, M., Cummins, S., Sparks, L., Findlay, A. Validating Health Impact Assessment: prediction is difficult (especially about the future) Environmental Impact Assessment Review 27(2007):101-107.

[42] Dannenberg, A., Bhatia, R., Coie, B.L., Dora, C., Fielding, J.E., Kraft, K., et al. Growing the Field of Health Impact Assessment in the United States: An Agenda for Research and Practice. American J Public Health. 96(2006): 262-270.

[43] Wright, J., Parry, J., Jonathan, J. Participation in health impact assessment: objectives, methods and core values. Bulletin WHO. (2005): 83 (1).

[44] Joffe, M., Mindell, J. Health Impact Assessment. Occ Env Med. 62(2005):907–912.

[45] Social Security Office, Ministry of Labor. [Online]. 2010. Available from: http://www.sso.go.th/wpr/ [2010, June 30]

[46] Department of Industrial Works, Ministry of Industry [monograph on the internet]. [Online]. 2010. Available from: http://hawk.diw.go.th/. [2011, December 10].

[47] WHO Regional Office for Europe Evaluation and use of epidemiological evidence for environmental health risk assessment [Online]. 2000. Available from: http://www.euro.who.int/__data/assets/pdf_file/0006/74733/E68940.pdf [2010, June 30]

[48] Nusselder, W.J., Mackenbach, J.P., Smit, J., DYNAMO-HIA. Development of a Dynamic Modeling Tool to Assess Health Impact of Policies. Final report. Rotterdam: Department of Health. (2011).

[49] INTARESE/HEIMTSA. Integrated Assessment of Health Risks of Environmental Stressors in Europe/Health and Environment Integrated Methodology and Toolbox for Scenario Assessment [Online]. 2010. Available from: http://www.integrated-assessment.eu/ [2011, June 30]

[50] Hoogenveen, R.T., van Baal, P.H., Boshuizen, H.C. Chronic disease projections in heterogeneous ageing populations: approximating multi-state models of joint distributions by modeling marginal distributions. Math Med Bio. 27(2010):1-19.

[51] Guide for stakeholder participations in HIA North American HIA Practice Standards Relating to Stakeholder Participation by HIA [Online]. 2010. Available from: http://www.healthimpactproject.org/resources#toolkits [2011, June 30].

[52] Methodology: Models (taxonomy of HIA) [Online]. 2009. Available from: http://www.ph.ucla.edu/hs/health-impact/models.htm [2011, June 30].

[53] Ministry of Public Health. Health Impact Assessment Guideline for Water Resources Development Project. (2010).

[54] Constitution of The Kingdom of Thailand. (2007)

[55] National Health Commission Office National Health Act. (2007).

[56] Chatree Gold Mine [Online]. 2010. Available from: http://www.kingsgate.com.au/company/chatree-gold-mine.htm [2011, August 10]

[57] Map Ta Phut Industrial Estate [Online]. 2010. Available from: http://www.mtpie.com/home.php [2011, August 10]

[58] Office of Natural Resources and Environmental Policy and Planning, The Ministry of Natural Resource and Environment (MONRE) Guideline for water resources development project. (2008).

[59] Sukkumnoed, D., Sabrum, N., Nuntavorakarn, S. HIA development report 2007-2008 [Online]. 2010. Available from: http://www.nationalhealth.or.th [2011, June 12]

[60] Mahaphant Fibre-Cement Public Co., Ltd. [monograph on the internet]. [cited 2011 Dec 10]. Available from: http://www.mahaphant.com/en/about-mahaphant/history.jsp.

[61] Thai Industrial Standards Institute, Ministry of Industry. [monograph on the internet]. [cited 2011 Dec 15]. Available from: http://www.tisi.go.th./

[62] Ministry of Labor. Occupational exposure limits for dust and chemicals in environment. (2010).

[63] Thepaksorn P, Pongpanich S, Siriwong W, Chapman RS, Taneepanichskul S Respiratory symptoms and patterns of pulmonary dysfunction among roofing fiber cement workers in the South of Thailand J Occ Health, 2012.

[64] Burdorf A and Vantonggeren M. Variability in Workplace Exposures and the Design of Efficient Measurement and Control Strategies. Ann. Occ Hyg. 47(2003):95–99.

[65] Kromhout H, Symanski E, Rappaport SM. A comprehensive evaluation of within- and between-worker components of occupational exposure to chemical agents. Ann. Occ Hyg. 37(2003): 253–70.

[66] US Occupational Safety and Health Agency 2011. [monograph on the internet]. [cited 2011 April 11]. Available from: http://www.osha.gov/SLTC/healthguidelines

[67] Environmental samplings for Mahaphant Fibre-Cement Public Co., Ltd. (2011). (unpublished manuscript).

[68] Manual for environmental samplings and walk-through survey in Ministry of Labor

[69] UK Health and Safety Executive (HSE) Portland Cement Dust Hazard assessment document. (2002).

[70] Singh-Manoux, A., Gue´guen, A., Martikainen, P. Self-rated health and mortality: short- and long-term associations in the Whitehall II Study. Psychosom Med. 2007;69 (2):138–143.

[71] McGee, D.L., Liao, Y., Cao, G., Self-reported health status and mortality in a multiethnic US cohort. Am J Epi. 149(1999):41–46.

[72] Ernstsen, L., Nilsen, S.M., Espnes, G.A. The predictive ability of self-rated health on ischaemic heart disease and all-cause mortality in elderly women and men: the Nord-Trondelag Health Study (HUNT). Age Ageing. 40(2011):105–111.

[73] Lima-Costa, M., Cesar, C., Chor, D., Proietti, F. Self-rated Health Compared With Objectively Measured Health Status as a Tool for Mortality Risk Screening in Older Adults: 10-Year Follow-up of the Bambuı´ Cohort Study of Aging. Amer J Epi. (2011).

[74] DeSalvo, K.B., Fan, V.S, McDonell ,M.B. Predicting mortality and healthcare utilization with a single question. Health serv. Res. 40(2005):1234–1246.

[75] Hengpraprom, S., Bualert, S., Sithisarankul, P. Testing a health impact assessment tool by assessing community opinion about a public park. Southeast Asian J Trop Med Pub Health. 43(2012):229-235.

[76] Veerman, J.L., Mackkenbach, J.P., Barendregt, J.J. Validity of predictions in health impact assessment. J Epi Comm Health. 61(2007):362-366.

[77] Cheungsatiensup, K. Spirituality and health: an initial proposal to incorporate spiritual health in health impact assessment. Env. Impact Ass Review. 23(2003):3-15.

[78] Thepaksorn, P., Pongpanich, S., Siriwong, W., Chapman, S.R. Roofing material processing workers' risk: a case study at roofing fiber cement factory in Thailand. J Health Res. (2013).

[79] Information and Communication Center, MOPH Java Health Information System (JHCIS) manual for health center and primary care unit. [Online]. 2010. Available from: http://www.jhcis.net [2011, December 10].

[80] Forgate, G.T. Practical sample size calculation for surveillance and diagnostic investigations J. Vet Diag Invest. 21(2009):3-14.

[81] The Institute of Medicine (IOM). [Online]. 2010. Available from: http://www.iom.edu/About-IOM.aspx [2010, September 10]

[82] American Thoracic Society (ATS). Diagnosis and initial management of nonmalignant diseases related asbestos J Respi Cri Care Med. 170(2004): 691-715.

[83] Desomritrutai, W., Nora, A. , Mararetra, H., Reference Spirometric values for healty lifetime smoker in Thailand. J Med Assoc. 83(2000): 457-466.

[84] AbuDhaise, B.A., Rabi, A.Z., al Zwairy ,M.A., el Hader, A.F., el Qaderi, S. Pulmonary manifestations in cement workers in Jordan. J Occ Med Env Health. 10(1997): 417–28.

[85] Lock, K., McKee, M. Health impact assessment: assessing opportunities and barriers to intersectoral health improvement in an expanded European Union. J. Epi Com Health. 59(2005):356–360.

[86] International Council on Mining and Metals. Good practice guidance on occupational health risk assessment. (2007).

APPENDICES

APPENDIX A

Walk-Through Survey Report

Section I Administrative Information

1.1 General Information

Name of Establishment	....
Type of Establishment	....
Address	....
Product types	....
Year of business start	....
Total no. employees	....
Number of work shift	....
Does this factory have worker union?	☐ Yes ☐ No

Location and Address in Brief

Establishment Layout of Roofing Tiles Fiber-Cement Manufacturing Process

1.2 Facilities Supports & Benefits

Items	Available	N/A
1. Clean drinking water ( )		
2. Canteen or clean area for lunch and break If YES, it is located outside or separate from work environment?		
( ) 1 Yes ( ) 2 No		
3. Zink (4 points)		
4. Bathroom ( )		
5. Toilet		
6. Changing clothes or uniform		
7. Changing room/storage		
8. Common room If YES, please specify		
( ) 1 inside the factory ( ) 2 outside the factory		

1.3 Health Care Services

Items	Available	N/A
1. Medicine and supplies		
2. First aid room		
3. Occupational physician or occupational nurse		
4. Work hour of physician…-… hrs/day and.....-.... day/ week		
5. Work hour of nurse …-… hrs/day and.....-..... day/ week		
6. Employees pass first aid training course		
7. Registered hospital for medical service If YES, please specify …………………		
8. Provided hospital under workmen compensation fund If YES, please specify ………………………..		
9. Provided medical insurance and related Life insurance If YES, please specify ……………………………		
10. Physical examination for new employees and if they are recruited to new job/position ( ) 1 Yes ( ) 2 No		
If YES, medical examination is: .... Ears .... Blood .... Eyes .... Urine .... Chest X-ray .... Pulmonary function test .... Other, please specify...		
11. Follow up and fiscal physical examination If YES, medical examination is: .... Ears .... Blood .... Eyes .... Urine .... Chest X-ray .... Pulmonary function test .... Other, please specify....EKG/ BUN Cholesterol Liver and Kidney function		

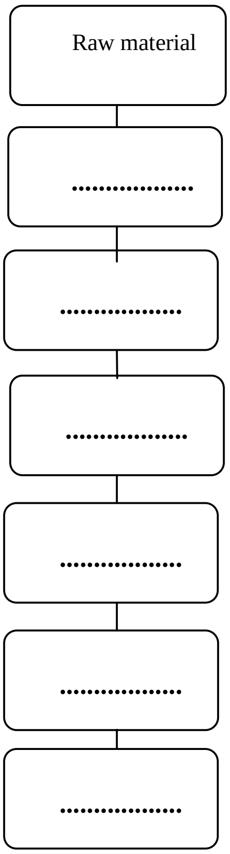
1.3 Health Care Services (cont.)

Items	Available	N/A
12. Rehabilitation in case employee has occupational injuries and illnesses If YES, please specify (how)..		
13. Employment disability employees who have occupational injuries and illnesses to new job or position		
14. Medical examination record (If YES, please provided)		

1.4 Occupational Health and Safety **Yes** **No**

Items	Available	N/A
1. Providing personal protective equipment (PPE) If YES, provided PPE is: ( ) 1 Hard hat ( ) 6 Shoes (Boots) ( ) 2 Eye goggle ( ) 7 Gloves ( ) 3 Mask ( ) 8 apron ( ) 4 Ear muffs ( ) 9 Insulator clothes ( ) 5 Ear plugs ( ) 10 Other, please specify Safety belt etc. If YES, please specify ( ) 1 Provided, please specify.................................... ( ) 2 Employee paid a half, please specify …….......... ( ) 3 Employee paid full, please specify..................... ( ) 4 Other, please specify... If YES, how often, specify…………...…………….…………….		
2. Occupational safety personnel (one occupational hygienist)		
3. Occupational health and safety training		
4. Providing occupational health and safety in factory, i.e., poster, morning talk, etc.		
5. Occupational health and safety promotion activities, i.e., occupational health and safety such as occupational health and safety week		

Section II: Production process and raw material uses (figure)

Production Process and Procedure	Production Process	Raw Material and Chemical Uses
		

Section III: Environmental and Occupational Hazards

Section	Process	No. Workers Exposed to Environmental and Occupational Hazards						No. employee(s) in this section
		Dust	Chemical Agent	Noise	Heat	Light	Other, please specify	
	1.................................. 2.................................. 3.................................. 4.................................. 5.................................	....	....	....	....	....	....	....
	1.................................. 2.................................. 3.................................. 4.................................. 5.................................	....	....	....	....	....	....	....
	1.................................. 2.................................. 3.................................. 4.................................. 5.................................	....	....	....	....	....	....	....
	1.................................. 2.................................. 3.................................. 4.................................. 5.................................	....	....	....	....	....	....	....

Section IV: Environmental Survey

Item	Process/Procedure	Section	Section	Section	Criteria
1. Environmental health hazards	1. Dust levels in production process and procedure				0- Low dust levels 1- Dust levels in the air, but not in the floor 2- Dust levels in the air and high levels in the floor
	2. Chemical or organic volatile levels in production process, e.g., Toluene, benzene, etc.				0- No smell of chemical or organic volatile 1- Smell of chemical or organic volatile under ventilation control system 2- Smell of chemical or organic volatile without ventilation control system
	3. Carbon monoxide (CO) levels in production process				0- Open with high ceiling with ventilation system such as fan 1- Open with high ceiling with ventilation system such as fan but does not operate 2- Close without ventilation system
	4. Noise level in production process				0- Less than 85 dB(A) 1- 85-90 dB(A) 2- > 90 dB(A)
	5. Light levels at work station				0- > 200 Lux 1- 51-199 Lux 2- < 50 Lux
	6. Light levels in building				0- > 20 Lux 1- 10-19 Lux 2- < 10 Lux
	7. Heat				0- Open air building/ventilation system 1- No ventilation system or have ventilation system but doesn’t operate 2- No ventilation system
	8. Mechanical and equipment safety ( ) No safety protection for mechanical and equipment available (i.e., cut, press, rotate, etc.) ( ) Work station unsafe or in secured ( ) Mechanical and equipment in worn out or poor maintenance ( ) Mechanical and equipment in worn out or poor maintenance but still in use ( ) Other, please specify… .				0- Not found 1- Meet only one item and could be correct 2- Meet one or more items without correction

Item	Process/Procedure	Section	Section	Section	Criteria
	9. Unsafe operation/working ( ) Tease while working ( ) Use mechanical or equipment incorrect and unsafe ( ) Inappropriate wearing clothes ( ) Not use PPE or use with inappropriate ( ) Use inappropriate PPE ( ) Smoking and eating while working ( ) Other, please specify…				0- No found 1- Meet only one item 2- Meet more than one items
2. Prevention and control	10. Local ventilation system				0- Operated ventilation system 1- Few operated ventilation system or insufficient ventilation system 2- No ventilation system
	11. General ventilation system				0- Open area < 1/10 of total area and ceiling level > 3.5 m 1- Open area < 1/10 of total area or ceiling level > 3.5 m 2- Close or ventilation system less than 1/10 and ceiling < 3.5 m
	12. Noise control level system in production process				0- < 90 dB(A) 1- > 90 dB(A) with using PPD in some occasion or insufficient 2- > 90 dB(A) without appropriate control system
	13. Fire protection ( ) Distinguished fire equipment (1 unit/ 100 sqm) and promptly use ( ) Distinguished fire equipment has been checked and ready to use ( ) Fire exit door without any obstruction or locked ( ) Explosive and flammable substance are storage with ventilation system ( ) Explosive and flammable substance waste disposal management ( ) Plug and switch have been checked ( ) Other, please specify......................................				0- Every items has been checked 1- No more than 2 items are needed to correct 2- More than 2 items are needed to correct

Item	Process/Procedure	Section	Section	Section	Criteria
	14. Mechanical hazards ( ) Providing protective equipment or shield for OSH protection ( ) Mechanical equipment maintenance (i.e., inspection, clean-up, lubricant, etc) ( ) Mechanical equipment has been signed for area permission ( ) Other, please specify...				0- Every items has been checked 1- No more than 2 items are needed to correct 2- More than 2 items are needed to correct
	15. Personal protective equipment (PPE)				0- Appropriate and adequate PPE use 1- Inappropriate or inadequate PPE use 2- No PPE
	16. Sign				0- Poster and sign have been placed appropriately 1- Poster and sign have been placed inappropriately with lack of maintenance 2- No poster and sign
	17. Occupational health and safety training				0- Orientation program at the beginning related to mechanical uses, procedure and production process and health hazards 1- Orientation program while working related to mechanical uses, procedure and production process and health hazards 2- No orientation program related to mechanical uses, procedure and production process and health hazards
	18. Food & beverage and smoking policy				0- No food and beverage or smoking permission sign has been placed in work settings and canteen with area providing 1- No food and beverage or smoking permission sign has been placed in work settings and canteen without area providing 2- No food and beverage or smoking permission sign
	19. Well management and cleaning up				0- Well maintenance with clean-up chemicals & equipment 1- Fairly maintenance with clean-up chemicals & equipment 2- Poor maintenance and

					clean-up chemicals & equip.
Item	**Process/Procedure**	**Section**	**Section**	**Section**	**Criteria**
3. Welfare and benefits	20. Bathroom and utilities				0- Clean bathroom(shower) with clean water supply 1- Not enough clean bathroom(shower) or enough but not clean 2- Not enough and clean bathroom(shower) available **Criteria:** 1-80 workers/toilet If > 80 workers, add one more toilet
	21. Restroom and utilities				0- Clean toilet with clean water supply and hygiene condition 1- Not enough clean toilet or enough but not clean 2- Not enough and clean toilet available **Criteria:** No. worker / Required toilet: 1-15 / 1; 16-40 / 2; 41-80 / 3 1-80 workers/restroom If > 80 workers, add one more toilet
	22. Sink				0- Clean and enough sink with soap available 1- Not enough or unclean sink available 2- Not enough and unclean sink available **Criteria:** No. worker / Required sink: 1-15 / 1; 16-40 / 2; 41-80 / 3 1-80 workers/sink If > 80 workers, add one more sink
	23. Drinking water				0- Clean drinking water supply 1- Clean drinking water in enough or enough but unlearned 2- In enough and un-cleaned **Criteria:** No.worker / Required drinking water: 1-40 / 1; 41-80 / 2 1-80 workers/drinking water unit If > 80 workers, add one more sink

Item	**Process/Procedure**	**Section**	**Section**	**Section**	**Criteria**
	24. First aid				0- Enough medicine and medical supplies available 1- In enough medicine or medical supplies available 2- No medicine and medical supplies available
	25. Health insurance benefits				0- Health insurance coverage under registered hospital 1- Health insurance coverage with conditional approve 2- No health insurance coverage
	26. Physical examination 26.1 Fiscal physical examination 26.2 Follow-up physical examination (i.e., 6-moth)				0- Fiscal physical examination (full) 1- Fiscal physical examination 2- No fiscal physical examination before and leave the job

Section V Post Assessment of a Walk-Through Survey

Assessor Name...
Establishment Name...
Type of Establishment…..

Priority Needs Improvement (List Items)	**Department (Section)**	**Comments & Recommendations**
1. Need improvement....... .... 2. Additional required improvement....................	....	.... ……………………………..….

Results...
....
....
....

Section VI Environmental and Occupational Health Hazards Results

Department (Section)	Air monitoring			Noise dB(A)	Light (Lux)	Heat WBGT (°C)	Other
	Dust/airborne	Name	Conc. (ppm)				

APPENDIX B

Sampling Methods and Protocols

Particulates not otherwise regulated, Total dust

DEFINITION: total aerosol mass
METHOD: 05000
OSHA: 15 mg/m^3
NIOSH: no REL
ACGIH: 10mg/m^3, total dust less than 1% quartz
SAMPLING
SAMPLER: FILTER (tared 37-mm, 5-µm PVC filter)
FLOW RATE: 1 to 2 L/min
VOL -MIN: 7 L @ 15 mg/m^3
-MAX: 133L @ 15 mg/m^3
SHIPMENT: routine
SAMPLE
BLANKS: 2 to 10 field blanks per set
BULK SAMPLE: none required
MEASUREMENT
TECHNIQUE: GRAVIMETRIC (FILTER WEIGHT)
ANALYTE: airborne particulate material
EQUIPMENT:

1. Sampler: 37-mm PVC, 2- to 5-µm pore size membrane or equivalent hydrophobic filter and supporting pad in 37-mm cassette filter holder.
2. Personal sampling pump, 1 to 2 L/min, with flexible connecting tubing.
3. Microbalance, capable of weighing to 0.001 mg.
4. Static neutralizer: e.g., Po-210; replace nine months after the production date.
5. Forceps (preferably nylon).
6. Environmental chamber or room for balance (e.g., 20 °C ± 1 °C and 50% ± 5% RH).

MEASUREMENT:
Weigh each filter, including field blanks. Record the post-sampling weight, (mg). Record anything remarkable about a filter (e.g., overload, leakage, wet, torn, etc.)

Source: NIOSH Manual of Analytical Methods (NMAM), Fourth Edition

APPENDIX C

Particulates not otherwise regulated, Respirable dust

DEFINITION: aerosol collected by sampler with 4-µm median cut point
METHOD: 0600
OSHA: 5 mg/m^3
NIOSH: no REL
ACGIH: 3 mg/m^3
PROPERTIES: contains no asbestos and quartz less than 1%; penetrates non-ciliated portions of respiratory system
SAMPLING
SAMPLER: CYCLONE + FILTER (10-mm nylon cyclone, Higgins-Dewell [HD] cyclone, or aluminum cyclone + tared 5-µm PVC membrane)
FLOW RATE: nylon cyclone: 1.7 L/min
HD cyclone: 2.2 L/min
Al cyclone: 2.5 L/min
VOL -MIN: 20 L @ 5 mg/m^3
-MAX: 400 L
SAMPLE
STABILITY: stable
BLANKS: 2 to 10 field blanks per set
ACCURACY
RANGE STUDIED: 0.5 to 10 mg/m^3(lab and field)
MEASUREMENT
TECHNIQUE: GRAVIMETRIC (FILTER WEIGHT)
ANALYTE: mass of respirable dust fraction
BALANCE: 0.001 mg sensitivity; use same balance before and after sample collection
CALIBRATION: National Institute of Standards and
EQUIPMENT:
1. Sampler:
a. Filter: 5.0-µm pore size, polyvinyl chloride filter or equivalent hydrophobic membrane filter supported by a cassette filter holder (preferably conductive).
b. Cyclone: 10-mm nylon, aluminum cyclone (SKC Inc.)
2. Personal sampling pump, 1.7 L/min ± 5% for nylon cyclone, 2.2 L/min ± 5% for HD cyclone, or 2.5 L/min ± 5% for the Al cyclone with flexible connecting tubing.
3. Balance, analytical, with sensitivity of 0.001 mg.
4. Weights, NIST Class S-1.1, or ASTM Class 1.
5. Static neutralizer, e.g., Po-210; replace nine months after the production date.
6. Forceps (preferably nylon).
7. Environmental chamber or room for balance, e.g., 20 °C ± 1 °C and 50% ± 5% RH.
MEASUREMENT:
11. Weigh each filter, including field blanks. Record this post-sampling weight (mg), beside its corresponding tare weight. Record anything remarkable about a filter (e.g., visible particles, overloading, leakage, wet, torn, etc.).

Source: NIOSH Manual of Analytical Methods (NMAM), Fourth Edition

APPENDIX D

Questionnaire Interview for Employee

There are two-part:

Part 1: Descriptive of demographic characteristics and work history

1. Date of birth --/--/--
2. Age….Years
3. Weight….kg.
4. Height….cm.
5. Sex ☐ Male ☐ Female
6. Marital status ☐ Single ☐ Married ☐ Widowed/divorced/separated
7. Education level ☐ Primary ☐ Secondary ☐ High/convocational ☐ Associate ☐ Bachelor ☐ Higher bachelor ☐ Other (specify)…………………….
8. Type of employee ☐ Regular ☐ Subcontract
9. Job position ☐ Manager ☐ Head of department ☐ Contract employee ☐ Subcontract ☐ Other (specify)…………………….
10. Department ☐ Mixing and pulping ☐ Water injection ☐ Curing ☐ Depalleting and skid ☐ Injection ☐ QC ☐ Painting ☐ Accessory ☐ Storage ☐ Maintenance ☐ Office ☐ Other (specify)…………………….
11. Year employed…..years
12. Duration of work per week…..days
13. Working hour per day ……..hrs.
14. Previous employed position…………………..
15. Job characteristics and working environment
    - 15.1 Dust or chemical ☐ Yes ☐ No
    - 15.2 Heat or high temperature ☐ Yes ☐ No
    - 15.3 Smell and nuisance ☐ Yes ☐ No
    - 15.4 Dust or chemical contaminated clothes and body ☐ Yes ☐ No
    - 15.5 Ventilation system ☐ Yes ☐ No
    - 15.6 Other (specify)…………………….
16. Do you know about occupational health risks? ☐ Yes ☐ No
17. Did you attend occupational health and safety training? ☐ Yes ☐ No
18. Do you regularly perform according to this?
    - 18.1 Follow the occupational and safety rules ☐ Yes ☐ No
    - 18.2 Use mask protection ☐ Yes ☐ No
    - 18.3 Smoking ☐ Very ☐ Often ☐ Some ☐ Rare ☐ None
19. Did you attend personal mask protective training? ☐ Yes ☐ No
20. Did you have experience uncomfortable when you use mask?
    ☐ Very ☐ Often ☐ Some ☐ Rare ☐ None
21. Do you clean-up your work station after finishing?
    ☐ Everyday ☐ 2-3 times/week ☐ Once a week ☐ Less than once a week ☐ None
22. Do you clean-up your work equipment after finishing?
    ☐ Everyday ☐ 2-3 times/week ☐ Once a week ☐ Less than once a week ☐ None
23. How do you clean-up your equipment (method)?
    ☐ Vacuum ☐ Sweeping ☐ Wet cleaning ☐ Other (specify)………….

Part 2 Physical examination and pulmonary function test

In the past 12 months you have symptoms or experienced as followings:

1. Did you experience wheezing? ☐ Yes ☐ No (if no, please skip to Q 5)
   a. If yes, how your wheezing when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   b. When did you develop wheezing at the first time? Please specify ……………..
   c. How often do you have wheezing?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
2. Did you experience coughing? ☐ Yes ☐ No (if no, please skip to Q 5)
   a. If yes, how your coughing when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   b. When did you develop wheezing at the first time? Please specify ……………..
   c. How often do you have coughing?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
3. Did you experience chest tightness? ☐ Yes ☐ No (if no, please skip to Q 5)
   a. If yes, how your chest tightness when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   b. When did you develop chest tightness at the first time?
      Please specify ……………..
   c. How often do you have chest tightness?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
4. Did you experience shortness of breath? ☐ Yes ☐ No (if no, please skip to Q 5)
   a. If yes, how your shortness of breath when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   b. When did you develop shortness of breath at the first time? Please specify ……………..
   c. How often do you have shortness of breath?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
5. Do you smoking? ☐ Yes ☐ No (if no, please skip to Q6)
   How many per day?..........items
   How long…………year(s)
   Do you still active smoking?
      ☐ Smoker
      ☐ Ex-smoker (specify the time quit smoking…………………)
6. Do you drinking alcohol?
      ☐ None ☐ Less than once a week ☐ 2-3 times/week
      ☐ More than 3 times a week
      ☐ Ex-alcohol drinking (specify the time quit alcohol drinking………………….)
7. Do you have fiscal physical exams? ☐ Yes ☐ No (if no, please skip to Q 9)
8. The results of physical exam check ☐ Normal ☐ Abnormal
9. Do you test for hearing loss? ☐ Yes ☐ No (if no, please skip to Q 11)
10. The results of hearing loss test ☐ Normal ☐ Abnormal
11. Do you have pulmonary function test? ☐ Yes ☐ No (if no, please skip to Q 13)
12. The results of pulmonary function test ☐ Normal ☐ Abnormal
13. Does your family member have symptoms or diseases? (You can specify more than one items)
      ☐ TB ☐ Asthma ☐ Lung cancer ☐ High BP ☐ Allergy
      ☐ Other (specify)…………………….
14. Do you have symptoms or diseases? (You can specify more than one items)
      ☐ TB ☐ Asthma ☐ Lung cancer ☐ High BP ☐ Allergy
      ☐ DM ☐ Heart disease ☐ Other (specify)…………………….
15. Spirometry test results ………………………………………………………………

APPENDIX E

Questionnaire Interview for Community Participants

There are two-part:

Part 1: Descriptive of demographic characteristics and physical examination and pulmonary function test

1. Date of birth --/--/--
2. Age….Years
3. Weight….kg.
4. Height….cm.
5. Sex ☐ Male ☐ Female
6. Marital status ☐ Single ☐ Married ☐ Widowed/divorced/separated
7. Education level ☐ Primary ☐ Secondary ☐ High/convocational
   ☐ Associate ☐ Bachelor ☐ Higher bachelor
   ☐ Other (specify)…………………….

In the past 12 months you have symptoms or experienced as followings:

8. Did you experience wheezing? ☐ Yes ☐ No (if no, please skip to Q 9)
   a. If yes, how your wheezing when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   b. When did you develop wheezing at the first time? Please specify ……………..
   c. How often do you have wheezing?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
9. Did you experience coughing? ☐ Yes ☐ No (if no, please skip to Q 10)
   d. If yes, how your coughing when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   e. When did you develop wheezing at the first time? Please specify ……………..
   f. How often do you have coughing?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
10. Did you experience chest tightness? ☐ Yes ☐ No (if no, please skip to Q 11)
   g. If yes, how your chest tightness when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   h. When did you develop chest tightness at the first time?
      Please specify ……………..
   i. How often do you have chest tightness?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
11. Did you experience shortness of breath? ☐ Yes ☐ No (if no, please skip to Q 12)
   j. If yes, how your shortness of breath when did you stop continuous working for 2-3 days
      ☐ Better ☐ Not change/same ☐ Worse
   k. When did you develop shortness of breath at the first time? Please specify ……………..
   l. How often do you have shortness of breath?
      ☐ Everyday ☐ Every week ☐ Every month ☐ Rare
12. Do you smoking? ☐ Yes ☐ No (if no, please skip to Q13)
   How many per day?..........items
   How long…………year(s)
   Do you still active smoking? ☐ Smoker ☐ Ex-smoker (specify the time quit smoking…………………)
13. Do you drinking alcohol?
   ☐ None ☐ Less than once a week
   ☐ 2-3 times/week ☐ More than 3 times a week
   ☐ Ex-alcohol drinking (specify the time quit alcohol drinking………………….)

Part 1: Descriptive of demographic characteristics and physical examination and pulmonary function test (cont.)

14. Do you have fiscal physical exams? ☐ Yes ☐ No (if no, please skip to Q 9)
15. The results of physical exam check ☐ Normal ☐ Abnormal
16. Do you test for hearing loss? ☐ Yes ☐ No (if no, please skip to Q 11)
17. The results of hearing loss test ☐ Normal ☐ Abnormal
18. Do you have pulmonary function test? ☐ Yes ☐ No (if no, please skip to Q 13)
19. The results of pulmonary function test ☐ Normal ☐ Abnormal
20. Does your family member have symptoms or diseases? (You can specify more than one items) ☐ TB ☐ Asthma ☐ Lung cancer ☐ High BP ☐ Allergy ☐ Other (specify)…………………….
21. Do you have symptoms or diseases? (You can specify more than one items)
    ☐ TB ☐ Asthma ☐ Lung cancer ☐ High BP ☐ Allergy
    ☐ DM ☐ Heart disease ☐ Other (specify)…………………….
22. Spirometry test results ……………………………………………………………….

Part 2 Self-health risk assessment

Self Health Risk Assessment According to Health Determinants	**Yes**	**No**
1.Physical assessment aspects (in last 6-month)		
1.1 Anyone of your family members or you has respiratory symptoms and illnesses such as allergies, common cold, coughing, nasal congestion, difficult to breath, and dry mouth.		
1.2 Anyone of your family members or you has problem related to nervous systems such as headache, dizziness, and drowsiness.		
1.3 Anyone of your family members or you has skin or dermal diseases such skin itchy, rash and eczema.		
2.Mental assessment aspects		
2. You are happy even though the factory was located near your neighborhood.		
2.2 You satisfy that the factory is located near your neighborhood since it improves your community.		
2.3 You satisfy for that the factory create job employment and income.		
2.4 You are confident that the owner of the factory takes good responsibility for waste management and control.		
2.5 You are worry or concern that the factory was established in your community.		
2.6 You are unhappy that the factory was established in your community since it creates toxic dust pollutions and releases chemical waste.		
2.7 The factory has changed community environment that threatened to your life and living?		
2.8 You are worry or stress when you are exposed to dust or chemical or contaminated drinking water released from the factory.		
3.Social assessment aspects		
3.1 Your community members or you have a good relationship with responsible person from the factory.		
3.2 The representative of the factory gives health information to you.		
3.3 The owner or employees and your community members have a good cooperation.		
3.4 The factory establishment creates job employment, improves economics and social improvement in your community.		
3.5 After the factory was established it improves your quality of living.		
3.6 The factory owner supports and facilitates environmental improvement in the community such as waste management and recycles.		
3.7 Advantages from job employment increase the gap between poor and rich family.		
3.8 After the factory was established the community members value on materialistic.		
3.9 After the factory was established the community has increased in drug use and crime.		
3.10 After the factory was established the community increases the conflict among community members.		
4.Spiritual assessment aspects		
4.1 The owner and employees treat your community members with humanized care.		
4.2 The owner and employees have respect in human rights you're your community members.		
4.3 The good cooperation between employees and your community members in preserving culture.		
4.4 The good cooperation and beneficial involvement between employees and your community members.		
4.5 Forgiveness between employees and your community members when the conflicts happened.		
4.6 The factory owner takes advantages from community in terms of natural resources and environment.		
4.7 After the factory was established the community members has higher income.		
4.8 The community members have selfish in community participation and involvement.		

APPENDIX F

Table 1 Observed production activities and sources of occupational exposure to cement dust and hazardous toxic chemicals in the roofing fiber cement processing industry

Occupational hazards	Department*						Criteria/Rating scale
	1	2	3	4	5	6	
Environmental health hazards							
1. Dust levels in production process and procedure	1	1	1	0	1	1	0- Low dust levels 1- Dust levels in the air, but not in the floor 2- Dust levels in the air and high levels in the floor
2. Chemical or organic volatile levels in production process, e.g., Cr (III), iron oxide, hydrogen chloride, methyl ethyl ketone, etc.	1	1	1	1	2	1	0- No smell of chemical or organic volatile 1- Smell of chemical or organic volatile under ventilation control system 2- Smell of chemical or organic volatile without ventilation control system
3. Carbon monoxide (CO) levels in production process	1	1	1	1	1	0	0- Open with high ceiling with ventilation system such as fan 1- Open with high ceiling with ventilation system such as fan but does not operate 2- Close without ventilation system
4. Noise level in production process	1	1	1	0	0	0	0- Less than 85 dB(A) 1- 85-90 dB(A) 2- > 90 dB(A)
5. Light levels at work station	1	2	2	2	2	2	0- > 200 Lux 1- 51-199 Lux 2- < 50 Lux
6. Light levels in building	1	2	2	2	2	2	0- > 20 Lux 1- 10-19 Lux 2- < 10 Lux
7. Heat	1	1	1	1	1	0	0- Open air building/ventilation system 1- No ventilation system or have ventilation system but doesn't operate 2- No ventilation system

* 1 = mixing and pulping (n=7), 2 = racking and curing(n=15), 3= de-paletting and skid(n=11), 4 = quality control(n=7), 5= painting and spraying(n=27), 6 = inspection and storage(n=55)

Table 1 Observed production activities and sources of occupational exposure to cement dust and hazardous toxic chemicals in the roofing fiber cement processing industry (cont.)

Occupational hazards	Department*						Criteria/Rating scale
	1	**2**	**3**	**4**	**5**	**6**	
Environmental health hazards							
8. Mechanical and equipment safety ( ) No safety protection for mechanical and equipment available (i.e., cut, press, rotate, etc.) ( ) Work station unsafe or in secured ( ) Mechanical and equipment in worn out or poor maintenance ( ) Mechanical and equipment in worn out or poor maintenance but still in use	0	1	1	0	0	0	0- Not found 1- Meet only one item and could be correct 2- Meet one or more items without correction
9. Unsafe operation/working ( ) Tease while working ( ) Use mechanical or equipment incorrect and unsafe ( ) Inappropriate wearing clothes ( ) Not use PPE or use with inappropriate ( ) Use inappropriate PPE ( ) Smoking and eating while working	2	2	2	1	1	2	0- No found 1- Meet only one item 2- Meet more than one items
Prevention and control							
10. Local ventilation system	1	1	1	0	1	1	0- Operated ventilation system 1- Few operated ventilation system or insufficient ventilation system 2- No ventilation system

* 1 = mixing and pulping (n=7), 2 = racking and curing(n=15), 3= de-paletting and skid(n=11), 4 = quality control(n=7), 5= painting and spraying(n=27), 6 = inspection and storage(n=55)

Table 1 Observed production activities and sources of occupational exposure to cement dust and hazardous toxic chemicals in the roofing fiber cement processing industry (cont.)

Occupational hazards	Department*						Criteria/Rating scale
	1	**2**	**3**	**4**	**5**	**6**	
Prevention and control							
11. General ventilation system	1	1	1	2	2	0	0- Open area < 1/10 of total area and ceiling level > 3.5 m 1- Open area < 1/10 of total area or ceiling level > 3.5 m 2- Close or ventilation system less than 1/10 and ceiling < 3.5 m
12. Noise control level system in production process	1	1	0	0	0	0	0- < 90 dB(A) 1- > 90 dB(A) with using PPD in some occasion or insufficient 2- > 90 dB(A) without appropriate control system
13. Fire protection ( ) Distinguished fire equipment (1 unit/ 100 sqm) and promptly use ( ) Distinguished fire equipment has been checked and ready to use ( ) Fire exit door without any obstruction or locked ( ) Explosive and flammable substance are storage with ventilation system ( ) Explosive and flammable substance waste disposal management ( ) Plug and switch have been checked	1	1	1	1	1	1	0- Every items has been checked 1- No more than 2 items are needed to correct 2- More than 2 items are needed to correct

* 1 = mixing and pulping (n=7), 2 = racking and curing(n=15), 3= de-paletting and skid(n=11), 4 = quality control(n=7), 5= painting and spraying(n=27), 6 = inspection and storage(n=55)

Table 1 Observed production activities and sources of occupational exposure to cement dust and hazardous toxic chemicals in the roofing fiber cement processing industry (cont.)

Occupational hazards	**Department***						**Criteria/Rating scale**
	1	**2**	**3**	**4**	**5**	**6**	
14. Mechanical hazards ( ) Providing protective equipment or shield for OSH protection ( ) Mechanical equipment maintenance (i.e., inspection, clean-up, lubricant, etc) ( ) Mechanical equipment has been signed for area permission	1	1	1	1	1	1	0- Every items has been checked 1- No more than 2 items are needed to correct 2- More than 2 items are needed to correct
15. Personal protective equipment (PPE)	1	1	1	0	1	1	0- Appropriate and adequate PPE use 1- Inappropriate or inadequate PPE use 2- No PPE
16. Sign	0	0	0	0	0	0	0- Poster and sign have been placed appropriately 1- Poster and sign have been placed inappropriately with lack of maintenance 2- No poster and sign
17. Occupational health and safety training	0	0	0	0	0	0	0- Orientation program at the beginning related to mechanical uses, procedure and production process and health hazards 1- Orientation program while working related to mechanical uses, procedure and production process and health hazards 2- No orientation program related to mechanical uses, procedure and production process and health hazards

* 1 = mixing and pulping (n=7), 2 = racking and curing(n=15), 3= de-paletting and skid(n=11), 4 = quality control(n=7), 5= painting and spraying(n=27), 6 = inspection and storage(n=55)

Table 1 Observed production activities and sources of occupational exposure to cement dust and hazardous toxic chemicals in the roofing fiber cement processing industry (cont.)

Occupational hazards	Department*						Criteria/Rating scale
	1	2	3	4	5	6	
18. Food & beverage and smoking policy	0	0	0	0	0	1	0- No food and beverage or smoking permission sign has been placed in work settings and canteen with area providing 1- No food and beverage or smoking permission sign has been placed in work settings and canteen without area providing 2- No food and beverage or smoking permission sign
19. Well management and cleaning up	1	1	1	0	1	1	0- Well maintenance with clean-up chemicals & equipment 1- Fairly maintenance with clean-up chemicals & equipment 2- Poor maintenance and clean-up chemicals & equipment
Welfare and benefits							
20. Bathroom and utilities	0	0	0	0	0	0	0- Clean bathroom(shower) with clean water supply 1- Not enough clean bathroom(shower) or enough but not clean 2- Not enough and clean bathroom(shower) available **Criteria:** 1-80 workers/toilet If > 80 workers, add one more toilet
21. Restroom and utilities	0	0	0	0	0	0	0- Clean toilet with clean water supply and hygiene condition 1- Not enough clean toilet or enough but not clean 2- Not enough and clean toilet available **Criteria:** No. worker – Required toilet: 1-15 – 1; 16-40 – 2; 41-80 – 3 1-80 workers/restroom If > 80 workers, add one more toilet

* 1 = mixing and pulping (n=7), 2 = racking and curing(n=15), 3= de-paletting and skid(n=11), 4 = quality control(n=7), 5= painting and spraying(n=27), 6 = inspection and storage(n=55)

Table 1 Observed production activities and sources of occupational exposure to cement dust and hazardous toxic chemicals in the roofing fiber cement processing industry (cont.)

Occupational hazards	Department*						Criteria/Rating scale
	1	2	3	4	5	6	
22. Sink	0	0	0	0	0	0	0- Clean and enough sink with soap available 1- Not enough or unclean sink available 2- Not enough and unclean sink available **Criteria:** No. worker / Required sink 1-15 / 1 16-40 / 2 41-80 / 3 1-80 workers/sink If > 80 workers, add one more sink
Welfare and benefits							
23. Drinking water	0	0	0	0	0	0	0- Clean drinking water supply 1- Clean drinking water in enough or enough but un-cleaned 2- Not enough and un-cleaned Criteria: No.worker / Required drinking water 1-40 / 1 41-80 / 2 1-80 workers/drinking water unit If > 80 workers, add one more sink
24. First aid	0	0	0	0	0	0	0- Enough medicine and medical supplies available 1- In enough medicine or medical supplies available 2- No medicine and medical supplies available
25. Health insurance benefits	0	0	0	0	0	0	0- Health insurance coverage under registered hospital 1- Health insurance coverage with conditional approve 2- No health insurance coverage
26. Physical examination 26.1 Periodical physical examination 26.2 Follow-up physical examination (i.e., 6-moth)	0	0	0	0	0	0	0- Fiscal physical examination (full) 1- Fiscal physical examination 2- No fiscal physical examination before and leave the job

* 1 = mixing and pulping (n=7), 2 = racking and curing(n=15), 3= de-paletting and skid(n=11), 4 = quality control(n=7), 5= painting and spraying(n=27), 6 = inspection and storage(n=55)

APPENDIX G List of Publications

Scientific Publications

1. Thepaksorn, P., Pongpanich, S., Siriwong ,W., Chapman, R.S., Taneepanichskul, S. Respiratory symptoms and patterns of pulmonary dysfunction among roofing fiber cement workers in the South of Thailand J Occ. Health, 2013.
2. Thepaksorn, P., Pongpanich, S., Siriwong, W., Chapman, S.R. Determining occupational health risks and hazards at roofing cement processing factory. J Health Research, 2013 (accepted, revised).
3. Thepaksorn, P., Pongpanich, S., Siriwong, W. Integrating human health into environmental impact assessment: review of health impact assessment from Thailand experiences, 2013 (manuscript is prepared for submitting to J. Env. Impact Ass Review).
4. Thepaksorn, P., Pongpanich, S., Siriwong, W. An application of self-health risk assessment among populations living in the vicinity of the roofing fiber cement factory, 2013 (manuscript is prepared for submitting to Asia Pacific J. Public Health).
5. Thepaksorn, P., Pongpanich, S., Siriwong, W., Boonyakarnkul, T. Chapman, S.R. Improving the use of evidence in health impact assessment for the roofing fiber cement industry, 2013 (manuscript is prepared for submitting to European J. Public Health).

Oral Presentations

1. Thepaksorn, P., Pongpanich, S., Siriwong ,W., Chapman, R.S., Taneepanichskul, S. Work-related Respiratory Symptoms and Patterns of Pulmonary Dysfunction among Roofing Cement Workers in the South of Thailand (Abstract) 12^{th} World Congress on Environmental Health Lithuania, May 22-27, 2012**.**
2. Thepaksorn, P., Pongpanich, S., Siriwong, W., Chapman, R.S., and Roofing Material Processing Workers' Risks: A Case Study at Roofing Fiber Cement Factory in Thailand (Abstract) 9th GeoTrop 2012, BKK, October 2-4, 2012**.**
3. Thepaksorn, P., Pongpanich, S., Siriwong, W., Boonyakarnkul, T. Chapman, S.R. Integrating health impact assessment tools into practice : a case study of cement industry in Thailand Institute of Public Health, University of Heidelberg, Germany November 10, 2012.

VITAE

Mr.Phayong Thepaksorn was born in 1973 in Trang Province. He earned a degree of Bachelor of Science in Pharmaceutical Sciences from Prince of Songkla University in 1996. He has been appointed as a senior lecturer at Sirindhorn College of Public Health, Trang since 1996 until present. He also received Master of Public Health degree from Mahidol University in 2001.

He received both degrees of Master of Public Health in Environmental and Occupational Health and Master of Sciences in Occupational and Environmental Exposure Science from the University of Washington, USA in 2006 and 2009 (the Royal Thai Scholarship). His research thesis entitled “Occupational injuries and accidents in Thailand” and “Measurement of atmospheric trace gases using ultraviolet differential optical absorption spectroscopy (UV-DOAS)” He also continued to pursue his PhD at College of Public Health Sciences, Chulalongkorn University. His research project is developing health impact assessment tools for a cement factory in Thailand.