การผนวกประเด็นความสนใจของผู้มีส่วนได้ส่วนเสียประกอบการประเมินประสิทธิภาพการจัดการด้านสิ่งแวดล้อม: กรณีศึกษาอุตสาหกรรมซีเมนต์ไทย

นางสาว ลักษณาวรรณ พลอำไพ

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INCORPORATION OF MULTI-STAKEHOLDER INTEREST FOR
A COMPREHENSIVE ENVIRONMENTAL PERFORMANCE EVALUATION
PROCEDURE: CASE STUDY OF A THAI CEMENT INDUSTRY

Miss Laksanawan Polompai

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ความสนใจของผู้มีส่วนได้ส่วนเสียได้ถูกนำมาผนวกเข้ากับการประเมินประสิทธิภาพการจัดการด้านสิ่งแวดล้อม ในขั้นตอนการเลือกประเด็นสิ่งแวดล้อมที่มีนัยสำคัญ และการพัฒนาดัชนีชี้วัด เพื่อให้ได้แนวทางการประเมินที่สอดรับมากขึ้นกับความต้องการของผู้มีส่วนได้ส่วนเสียที่เกี่ยวข้อง สำหรับโรงงานผลิตปูนซีเมนต์ที่เป็นตัวอย่างการศึกษา พบว่าปัญหาด้านมลพิษทางอากาศเรื่องฝุ่น ก๊าซซัลเฟอร์ไดออกไซด์ ก๊าซออกไซด์ของไนโตรเจน และก๊าซคาร์บอนไดออกไซด์ มีนัยสำคัญสูง และเมื่อนำประเด็นดังกล่าวมาพัฒนาดัชนีชี้วัด โดยพิจารณาความคาดหวังของผู้มีส่วนได้ส่วนเสีย พบว่าสามารถจัดแบ่งการประเมินออกเป็น 2 ด้าน คือ ประสิทธิผลด้านการจัดการ และประสิทธิผลด้านการดำเนินงาน ทั้งนี้ประสิทธิผลด้านการจัดการได้พิจารณาองค์ประกอบทางด้านความใส่ใจและมุ่งมั่นของผู้บริหารในประเด็นทางด้านสิ่งแวดล้อม และประสิทธิภาพของมาตรการที่ฝ่ายบริหารใช้ในการจัดการปัญหา ในขณะที่ประสิทธิผลด้านการจัดการแบ่งพิจารณาตามผลกระทบที่เกิดขึ้นทั้งทางตรงซึ่งบ่งชี้ภาระทางด้านสิ่งแวดล้อมอันเกิดจากกิจกรรมขององค์กร และผลกระทบทางอ้อมที่สะท้อนผลลัพธ์หรือความเสียหายที่เกิดจากภาระสิ่งแวดล้อมดังกล่าว นอกจากนี้ การศึกษายังได้รวบรวมข้อมูล และนำเสนอผลการประเมินตามดัชนีชี้วัดประสิทธิภาพการจัดการด้านสิ่งแวดล้อม ตามที่ได้นำเสนอเพื่อเป็นฐานสำหรับการทดสอบความเหมาะสมของแนวทางการประเมิน และใช้สำหรับการเปรียบเทียบผลการจัดการต่อไปในอนาคต

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LAKSANAWAN POLOMPAI: INCORPORATION OF MULTI-STAKEHOLDER INTEREST FOR A COMPREHENSIVE ENVIRONMENTAL PERFORMANCE EVALUATION PROCEDURE: CASE STUDY OF A THAI CEMENT INDUSTRY. THESIS ADVISOR : WIT SOONTARANUN, Ph.D., THESIS CO-ADVISOR : SOMPORN KAMOLSIRIPICHAIPORN, Ph.D., 98 pp. ISBN 974-17-3908-7.

Multi-stakeholder interest was incorporated into the environmental performance evaluation in the processes of significant environmental aspect identification and performance indicator development. The aim was to obtain an evaluation procedure that suits larger groups of relevant stakeholders. For the cement case study, it was found that air emission problems regarding to dust, sulfur dioxide, oxide of nitrogen, and carbon dioxide were highly significant. When developing the performance indicators for those aspects by taking stakeholders' expectation into account it was found that the evaluation of environmental performance could be classified in terms of management and operation. Management performance accounted for the intention and concern of the management on environmental issues and the effectiveness of measures used to manage the problems. On the contrary, operation performance concerned direct environmental impacts that indicate the burden to the environmental as a result of organization's activities and indirect impacts which reflect the outcomes or damages resulted from such burdens. In addition the information were collected and the performance indicators proposed were presented for being used in the test for an appropriateness of this procedure and utilized for future benchmarking.

Field of study Environmental Management Student's signature......Laksanawan P.......
(Inter-Department) Advisor's signature..............................
Academic year 2005 Co-advisor's signature..........................

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NOMENCLATURES

CEM	= continuous emission monitoring system
CSI	= cement sustainability initiative
DEQP	= Department of Environmental Quality Promotion
DIW	= Department of Industrial Works
ECI	= Environmental condition indicator
EIA	= Environmental impact assessment
EPE	= Environmental performance evaluation
EQA	= Natural environmental quality act
ISO	= International organization for standardization
MOSTE	= Ministry of science, Technology and environment
MPI	= Management performance indicator
NEB	= National environmental board
NEPA	= National environmental policy act
NGO	= Non government organization
NRCT	= National Research Council of Thailand
NSTDA	= National Science and Technology Development Agency
ONEP	= Office of natural resource and environmental policy and planning
OPI	= Operational performance indicator
PCD	= Pollution Control Department
SC	= Subcommittee for ISO14000
TC	= Technical Committee for ISO14000
TEI	= Thailand Environmental Institute
TISTR	= Thailand institute of scientific and technological research
UK	= United Kingdom
WMA	= Waste water management authority

CHAPTER I

INTRODUCTION

Environmental concern is an important issue for businesses nowadays. Pressure from communities, the government, and other businesses make companies place the improvement of their environmental performance high on their agendas. “Companies which respond fully and promptly to environmental issues will be in the strongest competitive position in terms of developing new products and markets and, in many cases, improving their efficiency…Those companies which do not respond will be at an increasing and perhaps fatal disadvantage” (ICAEW, 1992).

Environmental performance evaluation (EPE) is an ongoing, focused evaluation of the environmental performance of an organization. It is a method to measure the results of the organization’s management of the environmental aspects of its activities, products, or services. EPE is based upon the saying, “what gets measured gets managed” (CEEM, 1996). An organization may have many good intentions, however, if there is no system in place for ongoing evaluation and measurement, many of the good intentions will not be realized.

1.1 Statement of the problems

A rapid increase of industrial activities has led to a higher rate of natural resource depletion and intensified environmental degradation as a result of pollutants generated thereupon. Without jeopardizing future mankind’s well-being, a dedicate balance between economic prosperity, societal welfare and environmental burden must be defined. However, due to its extreme complexity, a lot more work has to be done in order to gain a clear understanding of the interactions between those triple bottom lines. Many tools are inevitably needed and being developed under the currently known framework of “sustainable development”. At present, the Environmental Performance Evaluation (EPE) has been accepted as a tool that helps integrate environmental issues with industrial practices.

Industrial evolution and urbanization have catalyzed the expansion of the cement industry to becoming one of the prime economic components nowadays. In many countries, the economic growth is closely tied to the cement business’ performance. The sustainability issue, therefore, becomes the major concern among the government and business community. At present, the integration of the concept of environmental protection and social responsibility into business practice has become more and more common. It is also known that the performance of an organization depends strongly not only on its operations but the community with which it involves. Therefore, it is necessary to develop a standard procedure for environmental performance evaluation that can be applied specifically to a local domain by including the environmental and social status exhibited therein. For this reason, it is important to study the satisfaction of stakeholders incorporated with a environmental performance evaluation. This study focused on the Thai cement industry.

1.2 Objective of the study

The main objective of this study is to assess the procedure for environmental performance evaluation for the cement industry that incorporates stakeholder needs into consideration by using the Siam Cement Industry (Ta luang), Khao Wong Plant as the case study.

1.3 Hypotheses

Suitable environmental performance should be assessed by considering the plant operations together with stakeholder satisfaction.

1.4 Scopes of study

1.4.1 The environmental performance evaluation was conducted at the Siam Cement Industry (Ta luang), Khao Wong Plant, 28 Moo 4 Na Pra Lan-Baan Krua road, Tombon Khao Wong, Pra Phutabat district, Saraburi province, based on the information obtained in the year 2004.

1.4.2 Only significant aspects were subjected to a detailed performance assessment.

1.5 Benefits of this study

This study is expected to contribute the following:

1.5.1 Guidance for creating an environmental performance evaluation of the Thai cement industry, which incorporates a stakeholders' engagement.

1.5.2 A practical way for an organization to assess the impacts of its activities on the environment and to evaluate its performance in managing those impacts accordingly.

CHAPTER II

BACKGROUND AND LITERATURE REVIEW

This chapter provides a description of the cement production process. The general concept of environmental performance together with various experiences on this field are also given. Lastly, stakeholder engagement in corporate environmental management is reviewed.

2.1 The cement production process

Cement industries in Thailand typically produce portland cement, which is a fine gray powder composed of dicalcium silicate, tricalcium silicate, tricalcium aluminate, and tetracalcium aluminoferrite, with the addition of calcium sulfate. Different types of portland cements can be manufactured based on the function of use and the chemical and physical properties desired. Portland cement types I - V are the most common. Portland cement plants normally operate continuously for long time periods (i.e., 6 months).

The process of cement production at the Siam Cement Industry (Ta luang), Khao Wong plant is based on the dry process with the following steps,

2.1.1 Raw material acquisition

Most of the raw materials used are obtained through quarrying. Usually limestone is the predominant raw material. This plant is located near a limestone quarry site where the limestone is extracted and supplied for cement production.

2.1.2 Raw material preparation

In this step, limestone from quarrying is crushed into a smaller size, about 75 millimeters, and belt conveyed to an open limestone storage yard. To make the characteristic of raw material uniformed, piling is necessary before supplying the raw materials to the cement plant. Other additives, i.e. clay, shale, and laterite, are imported and stored at the quarry site and later delivered by belt conveying system to the cement plant.

2.1.3 Raw material milling

Shale, laterite, clay and limestone from the preparation step are blended in the raw mill that possesses a control technology for accurate mixing proportions. The temperature is maintained at around 300°C by utilizing waste heat from the cement kiln's hot air exhaust. The products of this step are stored in the blending silo before being transferred to the kiln.

2.1.4 Pyroprocess

In pyroprocessing, the raw meal is pyrolyzed in a kiln to produce portland cement clinker. Clinker looks like hard, gray, spherical nodules with diameters ranging from 0.32 to 5.0 cm (1/8 to 2"); it is created from the chemical reactions between the raw materials. Pyroprocessing process starts when the raw meal of appropriate sizes and proportion are fed to a series of cyclonic heat exchangers where the remainding heat in the exit gas from the kiln is utilized for pre-heating the raw meals. After that, calcium carbonate, which is the major portion of the raw meal, is turned into calcium oxide at the precalciner ($CaCO_3$ = CaO + CO_2). Due to the exothermic nature of calcination, this unit consumed approximately 60% of the fuel load. After that, all materials are fed into the kiln at which the temperature is raised to around 1300 to 1,450 °C to enable the clinker formation, the thermal energy consumed at this stage accounts for approximately 40% of total fuel load.

2.1.5 Clinker cooling

After clinker formation is completed, the clinkers are taken out of the kiln while having a considerably high temperature of around 1,200°C. The prolongation of clinkers at a high temperature would change the product's properties due to extended chemical reactions between the components within the clinkers themselves. Therefore, the clinkers must be cooled down rapidly. In a clinker cooler, clinkers are transferred by moving grates while being cooled by crossing air stream. The exit air stream from the clinker cooling is redirected to the precalciner and kiln for heat recovery. The clinkers are cooled to a temperature of less than 100°C and stored in a clinker silo.

2.1.6 Cement milling

During the final step of Portland cement production, which is known as cement milling, the clinker is ground to make a fine powder. While grinding, an appropriate mix of gypsum and limestone is added for final product properties adjustment.

2.1.7 Packing and Transportation

Portland cement is pneumatically conveyed from the finish mill department to storage silos in the packhouse. Portland cement is withdrawn from silos by a variety of feeding devices and conveyed to loading stations in the plant or directly to transport vehicles using the same kind of material-transfer systems that are used to put the cement into the silos. Most of the Portland cement is shipped from the plant in bulk by rail or truck transport.

2.2 Environmental performance evaluation

At present, an environmental performance has been widely accepted as one of the important factors leading to the business success. The environmental performance evaluation (EPE) has been included in the international standard ISO 14000 series, ISO 14031 to be more specific. In the context of ISO 14000, The EPE can be defined as an "ongoing internal management process and tool that uses indicators to convey information that compares an organization's past and present environmental performance, with its environmental performance criteria".

2.2.1 Benefits of the EPE

The information generated from the EPE process may assist an organization by:

- Providing a better understanding of an organization's impacts on the environment.
- Providing a basis for benchmarking management, operation, and environmental performance.
- Identifying the opportunities for improving efficiency of energy and resource usage.
- Determining environmental objectives and targets that are being met.
- Demonstrating compliance with regulations.
- Determining proper allocation of resources.

- Increasing the awareness of employees.
- Improving community and customer relations

2.2.2 The EPE process model

Environmental performance evaluation is an internal management process. Within the EPE Standard procedure, there has been a definition of how the EPE should be ideally executed. This definition is inspired by the “plan-do-check-act” management model. The model involved following these planning, data collections and utilizations, and reviewing and improving environmental performance :

2.2.2.1 Planning EPE

The focus of planning efforts is the selection of environmental performance indicators, which should be based on significant environmental aspects. The environmental indicators can be classified into two broad categories (ISO 14031 guidelines, 1999).

a) Environmental performance indicator (EPIs) can be further divided into two types as follows:
   - Management performance indicators (MPIs), which provide information about management efforts to influence environmental actions and improvements. That is, the indicators relate to policy, people, practices, procedures, decisions, and actions at all levels of the organization.

- Operational performance indicators (OPIs), which provide information directly about the output of an organization's environmental activities. OPIs are concerned with various aspects of the organization. The use of resources, energy and various other materials are possible subjects as OPIs or the inputs to the system. Outputs of the system should be assessed through OPIs as well; such as the products, services, wastes, heat, discharges, emissions, radiation, and many others.

b) Environmental condition indicators (ECIs), provide information about the conditions of the environment. This information can help an organization to better understand the actual impact or potential impact of its environmental aspects, and thus assist the planning and implementation of an environmental performance evaluation.

2.2.2.2 Data collections and utilizations (DO)

Once the different elements have been identified and the indicators are initially drawn, the EPE Standard model suggests a second phase, which consists of developing and using the data. Thus, data are collected in order to provide inputs for estimating the selected indicators. Data can be collected from a variety of sources. Reports sent to or from regulatory agencies, scientific reports, training records, audits, financial data, production data, interviews, observations, internal monitoring data and inventory records are common forms of data that can be used during an EPE. Almost any source can be considered and if records are kept with its characteristics, there may be at least parts that could be used from time to time.

Once collected, the data must be analyzed and converted. This analysis should consider the data quality, validity, adequacy, and completeness necessary to produce reliable information. The information may be developed using calculations, best estimates, statistical methods, graphic techniques, indexing, aggregating or weighting.

The next step is the performance assessment based on the information processed by different methods. This means that the information generated through the EPIs will be evaluated with the organization's environmental performance criteria. This performance information will be reported or communicated to interested parties within and outside the organization, based on an assessment of the audience's needs. There are two types of communication: internal reporting and communicating, and external reporting and communicating.

2.2.2.3 Reviewing and improving environmental performance (Check and Act)

The EPE results should be reviewed periodically to identify opportunities for improving environmental performance. The review of the EPE results should address the following:

a) How appropriate the selected environmental performance indictors are

b) Data quality and data collection methods

c) How appropriate the environmental performance criteria are

d) The progress needed to meet the environmental performance criteria

2.3 Literature review

Certain components of the EPE have been practiced for ten to twenty years, but the EPE term is relatively new. The National Environmental Policy Act in the U.S. (NEPA) promoted the use of the systematic environmental impact assessment processes, which implicated many applications to the EPE. The NEPA resulted in the development of many different modeling systems, some of which are still being used to assess environmental impacts. Impact levels are related to environmental performance.

Horowitz (1995) found that environmental indices were used in the 1970s concerning travel zones and air pollution modeling results. This was not referred to as EPE, however, it incorporated some of the same concepts. Air pollution modeling, for example, helps the researcher determine the level of certain pollutant indices by using computers to model complex terrain and atmospheric conditions.

Hope (1992) studied an environmental index system developed in the UK in 1980 and 1988. Many different aspects of the environmental condition were assessed. This system consisted of objective environmental indicators and opinion poll results which were used to weight indicators into an aggregate index. This was one of the first reported attempts to aggregate environmental indicators.

By the early 1990s many countries around the world began to place their concerns on environmental impact assessments, which are related to the EPE. Ortolano (1995) estimated that over half of the nations in the world adopted some for of an assessment. He also stated that many of the major impacts have been reduced as the result of such assessments. This impact reduction has been due to the scaling back in size of some of the projects or the elimination of destructive components of an operation.

The World Bank is also involved in environmental assessment and sustainable development, which are related to the EPE. Querini (1993) reported that the World Bank conducted a study to assess the capital resources involved in sustainable development. This study resulted in several cost-effective environmental impact assessment strategies which can supplement an EPE.

The real development of environmental performance evaluation as presently defined started in the early 1990s with the work done by the Technical Committee ISO/TC207. After some concepts were identified, Subcommittee SC4 was established to develop environmental performance evaluation and published the first drafts of ISO 14031. This approach was initiated in the cement industry by B.V. Bahr et al. (2003) who investigated the importance of the data quality of operational performance indicators (emission factors in this case) as a limiting factor for benchmarking and external rating between six cement plants in Sweden, Norway, and Finland. Three types of emissions: dust, NO_x, and SO_2 were considered. One of the findings was that there was no sharp limit when the quality of emission factors was high enough to make it possible to compare, since quality was a qualitative conception in itself.

During the last decade, the cement industry has taken action to improve their environmental performance. In particular, the members of the cement sustainability initiative (CSI) have conducted intense evaluations on environmental performance. The core members of the CSI consisted of Cemex (2002), Cimpor (2003), Uniland Cementera, S.A. (2001), Heidelberg Cement (2002), Holcim (2003), Italcementi (2003), Lafarge (2003), RMC (2001), Taiheiyo Cement (2003), and Titan Cement Company S.A. (2003), Therefore, a number of environmental reports have been issued to communicate the performance of these companies.

The reports are based on data and information gathered and interpreted for their environmental indicators. The groups of environmental themes related to environmental indicators are as follows:

- Energy
- Materials
- Water
- Emissions, Climate Protection, and Waste
- Transport
- Land-Use/Biodiversity

Table 2.1 *Environmental performance indicators in an environmental report of the CSI group from years 2001-2003.*

Issue	Indicator	Cemex	Cimpor	Uniland	Heidelberg	Holcim	Italcementi	Lafarge	RMC	Taiheiyo	Titan
Energy	Total energy consumption *(MJ, MJ/ton clinker)*	/	/	/	/	/				/	
	Electricity Consumption *(kWh, kWh/ton clinker)*								/	/	
	Thermal Energy Consumption *(MJ, MJ/ton clinker)*									/	
	Total Fuel Consumption *(MJ, ton MJ/ton clinker)*								/		
	Alternative fuel Consumption *(MJ, ton of alternative fuel use, %)*				/	/	/	/		/	
	Fossil Fuel Consumption *(MJ, ton of fossil fuel use)*							/			
Materials	Total Raw materials Use *(ton raw materials use, ton raw materials use/ton cement)*	/	/	/		/		/			
	Alternative Raw Material Use *(ton alternative raw material use, % alternative raw material use)*		/				/				
Water	Water Consumption *(litre of water consumption, litre of water consumption /ton cement)*		/	/		/		/	/	/	/

Table 2.1 *Environmental performance indicators in an environmental report of the CSI group from years 2001-2003(Cont.).*

Issue	Indicator	Cemex	Cimpor	Uniland	Heidelberg	Holcim	Italcementi	Lafarge	RMC	Taiheiyo	Titan
Land use /Biodiversity	Quarry Land Use *(hectare, hectare/ton cement)*					/					
	Land rehabilitation *(hectare, % of quarries rehabilitation plan)*							/	/		/
Emissions	Particulates/dust *(kg particulates, g particulates/ton cement)*	/	/	/	/	/	/	/		/	/
	SO_2 *(kg SO_2, g SO_2/ton cement)*	/	/	/	/	/	/	/		/	/
	NO_2 *(kg NO_2, g NO_2/ton cement)*	/	/		/	/	/	/		/	/
	Mercury emission *(g mercury/ton cement)*							/			
	Dioxins/furans emission *(µg dioxins or furans/ton cement)*							/		/	
	CO_2 Emissions Reduction *(%, kg)*									/	
	CO_2 emission *(ton, ton of CO_2/ton cement)*	/	/	/	/	/	/	/	/	/	/
Waste	Total Waste Generation *(ton, ton/ton cement)*							/	/	/	
	Waste Land filled *(ton, ton/ton cement)*								/		
Transport	Transportation Mode *(% by rail, barge, etc.)*		/			/			/	/	

From the table, it can be seen that most reports described the performances related to emissions. This indicated that emission is of major concern in the cement industry. These indicators included dust, the oxide of nitrogen, and sulfur dioxide. The quantity of green house gas, carbon dioxide emission, is another indicator of interest. This reflected the concern on the global warming issue by the European Union.

2.4 Stakeholder engagement

In a stakeholder engagement, in the process of an environmental performance evaluation, it is important to consider the views of as many individuals as possible in the EPE planning and communication process. Each type of individual has their own issues, perspectives, concerns, and bias. Some people care about the environment while others care about economic factors, knowledge, and a variety of other things. If the views of all of these interested parties are factored into the EPE process, its likelihood of success will be increased.

Some researchers have developed methodologies for considering individuals' priorities and differences. Bowen (1994) reported that a methodology had been developed that would allow priority-setting in terms of individual differences and opinions. This method is entitled the probabilistic multidimensional scaling algorithm. It allows the team conducting an EPE to analyze the environmental priorities of other individuals in a more scientific format.

Freeman (1984) defined a stakeholder as "any group or individual who could affect or was affected by the achievement of the firm's objectives." Stakeholders of the firm may include employees, customers, suppliers, public interest groups and governmental bodies. He also categorized this stakeholder concept into a corporate planning and business policy model and a corporate social responsibility model of stakeholder management. The corporate planning and business policy model focused on developing and evaluating the approval of corporate strategic decisions by groups whose support was required for the firm to continue to exist. The behavior of various stakeholder groups is considered a constraint on the strategy setting by the management. In this model, stakeholders were identified as groups that were not adversarial in nature, such as customers, owners, suppliers and public groups. The corporate social responsibility model extended the prior model to include external influences that may assume adversarial positions such as regulatory bodies or environmentalist. As the level of stakeholder power increased, the importance of meeting stakeholder demands increased.

Ullmann (1985) presented a three-dimensional model to explain the relationship between social disclosure and social and economic performance. Stakeholder power was discussed as the first dimension of this model, explaining that a firm would be responsive to the intensity of stakeholder demands. Companies developed their reputation through social responsibility and disclosure because they wanted to balance stakeholder influence. The second dimension of the model is strategic posture. It described the mode of response of an organization's key decision makers toward social demands. A company whose management tried to influence their organization's status with key stakeholders through social responsibility activities possessed an active posture. The more active the strategic posture, the greater the expected social responsibility activities and disclosures. And the third dimension concerned the companies' past and current economic performance. Economic performance directly affected the financial capability to create social responsibility programs. Therefore the better the economic performance of a company, the greater its social responsibility activity and disclosure.

CHAPTER III

METHODOLOGY

The methodology was classified into 3 steps: Consideration of stakeholder requirements, Assessment of environmental performance and Suggestion of environmental performance evaluation for future work as shown in Figure 3.1.

3.1 Consideration of stakeholder requirements

As the stakeholder needs are crucial for environmental performance evaluation, the first step of this study involved the survey of stakeholder groups and their needs in terms of environmental issues regarding the activities of the production site selected. The tools used in this step included questionnaires, employee suggestions reviews of the vision and policy of management, and reviews of the targets and goals of environmental management. The stakeholders were first identified through their interactions with the plant both economically and socially as shown in Table 3.1

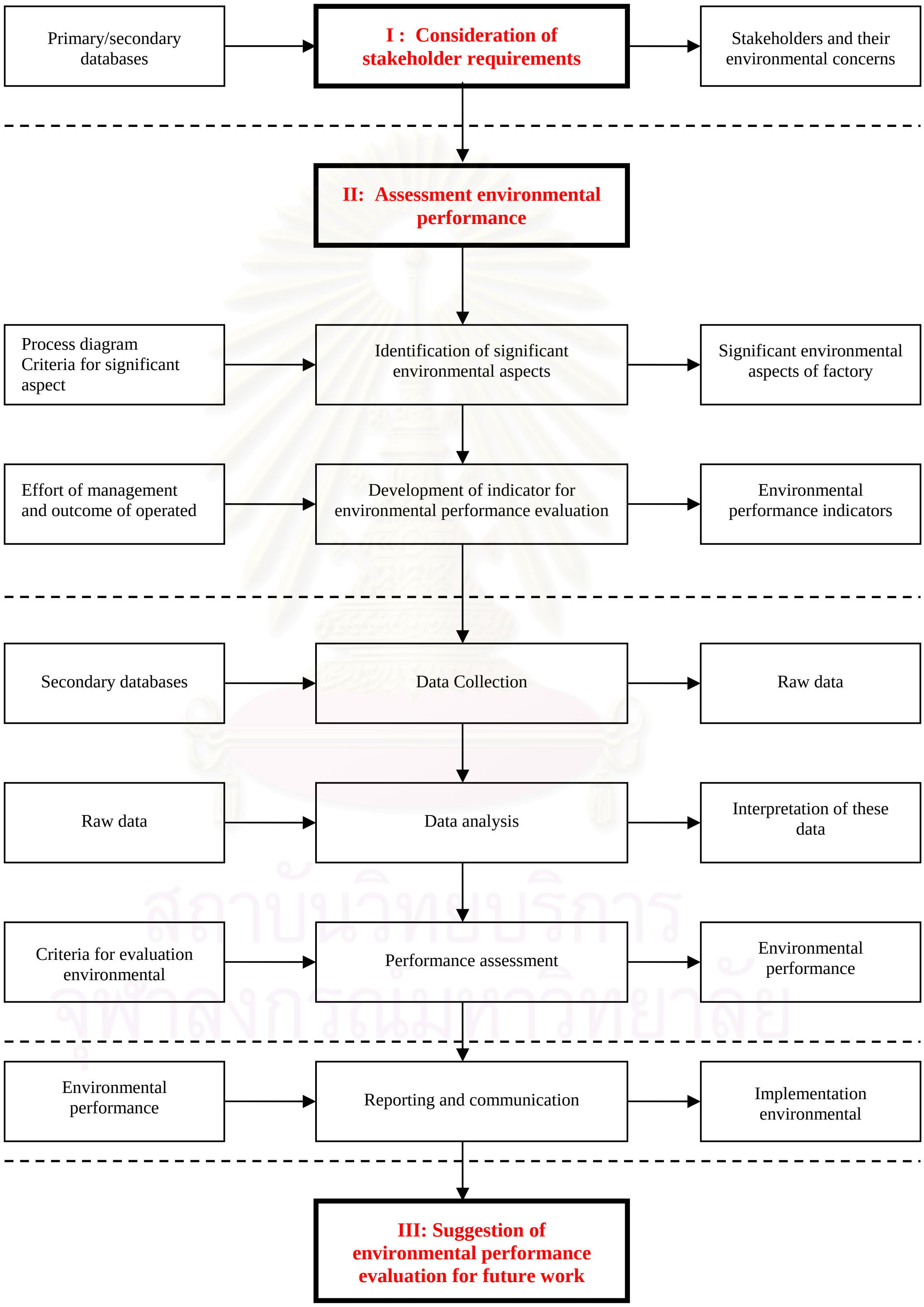

Primary/secondary databases
I : Consideration of stakeholder requirements
Stakeholders and their environmental concerns
II: Assessment environmental performance
Process diagram
Criteria for significant aspect
Identification of significant environmental aspects
Significant environmental aspects of factory
Effort of management and outcome of operated
Development of indicator for environmental performance evaluation
Environmental performance indicators
Secondary databases
Data Collection
Raw data
Raw data
Data analysis
Interpretation of these data
Criteria for evaluation environmental
Performance assessment
Environmental performance
Environmental performance
Reporting and communication
Implementation environmental
III: Suggestion of environmental performance evaluation for future work

Figure 3.1 *Research Methodology*

Table 3.1 *Stakeholders of the Khao Wong Plant*

Group	Body	Interaction	Method used to identify
Government	Department of Industrial Work (DIW)	Regulator of plant operation : Resource use and release of waste	Regulation
	Pollution Control Department (PCD)	Regulator of environmental quality	Regulation
	Office of Natural Resource and Environmental Policy and Planning (ONEP)	Regulator of plant operation : Resource use, release of waste, safety and health and social impact	Regulation
Neighbor	The communities at Khao Wong	Health and environmental impact	Survey
Employee	Employees and contractors who wok in cement plant	Safety and health of employee	Survey
Management	Management of cement plant	Policy and vision about environment	Policy and vision

3.2 Assessment of environmental performance

The steps of assessment environmental performance are as follows:

3.2.1 Planning

The planning step focuses on the environmental aspects of the factory. This step was carried out to assess the significant aspects and set up appropriate environmental related performance indictors. Therefore, it could be further divided into two categories:

a) Identification of significant environmental aspects.

In order to identify the significant aspects, the following three steps were performed:

- Environmental aspects were first identified by using a process flow diagram to examine the relationship between environmental aspects and production activities. This was called the process/site based approach.
- Criteria used for prioritizing aspects were then set by considering environmental risk criteria such as the hazardous level, exposure intensity, applicable legal requirements, and the concern of the internal and external interested parties
- Prioritizations of environmental aspects were performed in accordance with the scores obtained for each aspect using criteria set previously.

b) The development of indicators for environmental performance evaluation

Indicators for the EPE were selected based on considering the input-output model. This model involved measuring a factor that influenced an aspect (input) and then measuring a result of the action taken (output). Figure 3.2 presents the input-output model.

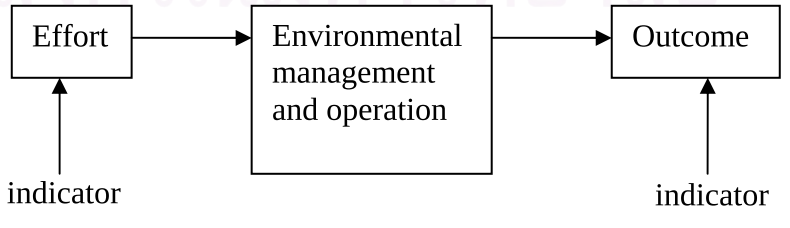


Figure 3.2 *Input-output model*

The indicators were classified as management and operational indicators.

- Environmental management indicators are concerned generally with action performed by management. Management indicators dealed with procedures, plans, and tracking. Examples included training plans, legal requirements, resource allocation, design of control systems, setting of goals, documentation, corrective action, level of program implementation, tracking of parameters and results, performance prediction, and the identification of root causes and other activities done primarily by management.
- Environmental operation indicators involved the actual emission, discharges, wastes generated, resources used and other aspects of the actual facility and equipment used to produce the product or service.

3.2.2 Performance assessment (DO)

The performance assessment step involved data collection, data analysis, and performance assessment.

a) Data Collection

Data required for each indicator were collected from the plant's operations. The data collected could be classified into two cases depending on their availability.

Case 1: Existing data. The primary data are gathered from organizational reports, records, etc.

Case 2: Data which are unavailable. The secondary data were obtained from elsewhere, for instance, scientific research documents, calculations, etc.

b) Data analysis

The steps of data analysis were to refine the raw data obtained to ensure that they are adequately simple while maintaining an acceptable quality. The set of data were recalculated as necessary employing common statistical tools. This enabled the interpretation of these data using common display formats such as graphs, tables, etc.

c) Performance assessment

Two steps of performance assessment were carried out as follows:

- The establishment of criteria for the evaluation of environmental performance. These criteria could be obtained from standards, scientific recommendation, and best practices.
- A performance assessment by comparing current performance with the criteria set previously through the indicators is developed for each significant aspect considered.

3.2.3 Reporting and communication

Reporting and communication were considered as the most critical step for EPE implementation. This was because any improvement would never be achieved without the cooperation from all related parties. The report of performance assessed was therefore used as a platform that brought all related parties together and drives the improvement activities. In this study, the appropriate means for communication are investigated.

3.3 Suggestion for using environmental performance evaluations for future work

Finally, the recommendations regarding the process of constructing an EPE in the cement plant studied were issued by close consultation with the major stakeholders, particularly manufacturers.

CHAPTER IV

RESULTS AND DISCUSSIONS

4.1 Consideration of stakeholder requirements

Identifying the relevant stakeholders and understanding their interests were the prerequisite for the development of an appropriate and meaningful environmental performance evaluation. The relationships of stakeholders were demonstrated in Figure 4.1. The stakeholder groups included employees, suppliers, customers, shareholders, local communities, governments, NGOs, and managers which were briefly discussed as follows.

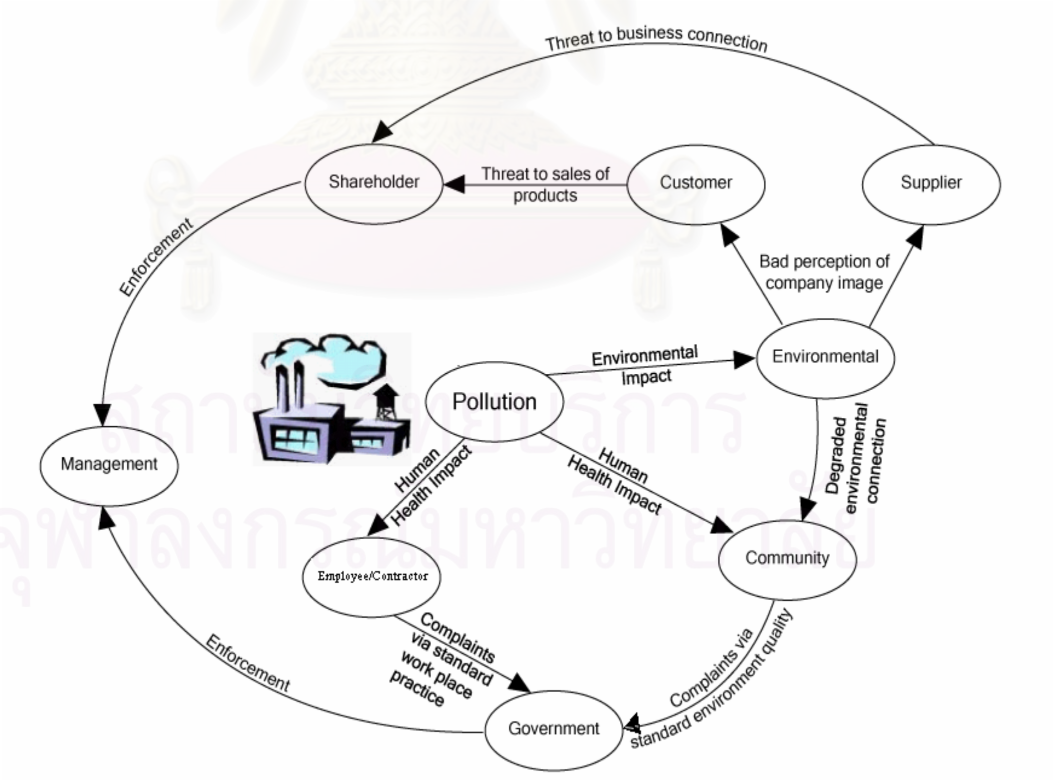


Figure 4.1 *The relationship of stakeholders in the cement industry*

4.1.1. Employees and contractors

The plant studied provided direct employment about 300 people. In addition to fair remuneration packages, the employees were likely to be interested in good, safe, and healthy working conditions, with opportunities for training and career development. These conditions can in turn be a motive for productivity improvements, lower labor absenteeism or turnover rate, and result in fewer union disputes. Many particularly experienced or educated employees tend to be more aware of other environmental aspects such as emission, noise, heat, trembling, and water and energy consumption.

The industry relied to a large extent on contractors and consultants for various parts of its operations, such as drilling, transport, permitting, and mine closure. Most contractors are concern about the economic performance of the company they are working for and their prospects for further contracts rather than environmental issues. Some consultants, particularly those involved in conducting environmental impact assessments (EIA), may have an interest in environmental aspects of a company’s activities as parts of their jobs.

4.1.2 Suppliers

Although being at the bottom of the supply chain, the mining and minerals sector still has a number of suppliers, including providers of energy and other materials. Like contractors, they are in general interested in the economic viability of the company to which they provide a service, and whether their contracts are paid in accordance with the terms of their agreements.

4.1.3 Customers

At present, the most influential consumers of cement are domestic construction works. Generally speaking, the consumers' main interests are the best quality cement products and services obtained at minimum costs, with no associated environmental, health, and safety risks.

4.1.4 Local communities

Demographics

The local communities surrounding the Khao Wong Plant consist of nine villages. The survey was conducted with 191 respondents out of total population of 2,959 people. Half were males (97 respondents, 51%) and the other haft were females (94 respondents, 49%). The majority of them were between 41 and 60 years of age (47% of all respondents). Their education profile was mixed between those who have received formal education (90%) and those who have not (10%). There were 106 respondents who had been living in this area for longer than 20 year (55%).

Survey results

Many types of communities can be affected by mining operations, including those neighboring the cement plant. Most communities are interested in a provision of employment (and through that the financial performance of the company), and also a clean and healthy environment. As a result, it is not a surprise why dust emission and water consumption came to the top of the list.

4.1.5 Governments and local authorities

Structure of Government

Thailand is a constitutional monarchy, with the King as the Head of State. The leader of the government is the Prime Minister, who presides over a cabinet of Ministers. The Thai Parliament is the supreme law-making authority, and consists of the Senate, whose members are appointed, and the House of Representatives, whose members are elected for four-year terms. The structure of governance is divided into national, provincial and district levels, with the provinces headed by governors and districts by district chiefs.

Environmental Institutions

Environmental management is conducted on a national basis by the Ministry of Science, Technology and Environment (MOSTE). The main departments under the MOSTE are the Office of Environmental Policy and Planning (OEPP), the Pollution Control Department (PCD) and the Department of Environmental Quality Promotion (DEQP). These are further divided into several divisions and regional offices which take care of specific environmental concerns at national and provincial levels.

The OEPP is the main body tasked with policy formulation and the development of environmental management plans. It coordinates with other national and provincial agencies in the development and implementation of these plans. The OEPP also coordinates the implementation of the Environmental Impact Assessment (EIA) system in Thailand, and is responsible for international cooperation. The PCD, as its name suggests, is in charge of pollution issues, and is concerned specifically with implementing pollution control laws and emission standards. The DEQP is responsible for promoting public education on the environment, and is responsible for environmental information, public and media relations, research and training as well as serving as the NGO liaison.

Apart from these three agencies, there exist a myriad of other bodies operating under the aegis of the MOSTE, which are involved with specific environmental issues. These include the Department of Energy Development and Promotion, the Department of Science Service, the Office of the National Research Council of Thailand (NRCT), the Office of Atomic Energy for Peace, the Thailand Institute of Scientific and Technological Research (TISTR), the National Science and Technology Development Agency (NSTDA), and the Waste Water Management Authority (WMA). A list of each ministry competences is shown in Table 4.1.

Table 4.1 *List of the areas competence of Thai ministries*

Ministry	Department / Agency	Area of Competence
Ministry of Agriculture and Cooperatives	Royal Forest Department	Forestry
	National Wildlife Protection and Reserves Board	Wildlife reserves
	Board of Land Development	Land use, including soil and water improvement
Ministry of Interior	Traffic Enforcement Division, National Police Agency	Pollution from traffic
	Department of Public Works	Sewerage
Ministry of Industry	Department of Geological Resources	Mining

In recognition of the widely dispersed authority over natural resources, the Thai government has established the National Environmental Board (NEB), which is a high-powered policy-making committee chaired by the Prime Minister. Members of the NEB include the Ministers of the respective sector ministries whose activities impinge upon the environment, the heads of relevant government boards as well as representatives from the private sector. Very significantly, the NEB aims to coordinate the environmental protection efforts of governmental agencies between the central level, and with those of local governments at the provincial level. The main powers of the NEB include the submission of policies and plans to the Cabinet for approval; the prescription of environmental standards; the approval of environmental quality management plans and provincial action plans; the amendment, improvement and enforcement of laws; and the monitoring of environmental compliance by government agencies and state enterprises.

Requirements of government

The government determines the operating frameworks for the industry by defining revenue and tax distribution, the planning process, and environmental standards, and by protecting the rights of the local communities. Therefore, they are interested in all aspects of environmental conditions, such as safe working practices and environmental compliance. The main framework for environmental legislation is the Enhancement and Conservation of the Natural Environmental Quality Act of 1992 (hereinafter “EQA”). The EQA is a fairly-substantive piece of legislation which contains several progressive provisions designed to enhance the protection of the environment. The other major environmental laws listed in Table 4.2 and Table 4.3.

Table 4.2 *Major environmental laws in Thailand*

Issue	Relevant Law
Pollution Control	• Factories Act 1992 • Notification of the Ministry of Industry Concerning Factory Wastes 1988 • Public Health Act 1992 • Cleanliness and Orderliness of the Country Act 1992 • Hazardous Substances Act 1992 • Notification of Ministry of Industry Concerning Storage and Disposal of Toxic Substances 1982 • Poisonous Substances Act 1967, amended in 1973 • Notification of Ministry of Industry Concerning Industrial Effluent Standards 1982 • Notification of Ministry of Industry concerning manufacture and use of toxic substances 1982
Energy	• Energy Conservation Promotion Act 1992 • Notification Concerning Duty Reduction on Energy Efficiency and Environmental Technology 1988
Mining	• Mineral Act 1967 • Petroleum Act Nos. 1 - 5 (1971, 1973, 1979, 1989, 1991)
Land Use and Planning	• Construction Building Control Act 1979 • City Planning Act 1975 • Land Reform for Agriculture Act 1975 • Investment Promotion Act 1977 • Industrial Estate Authority of Thailand Act (No. 3) 1996
Water Resources	• Groundwater Act 1977 • Groundwater Act (No. 2) 1992
Cultural/Natural Heritage	• Archaeological Sites, Antiques, Art Objects and National Museum Act 1961

Table 4.3 *Relationships between government and cement plant by laws and regulations*

Report	Government agency	Frequency	Content
Monitoring report of Environmental Impact Assessment (EIA)	Department of Natural Resources and Environmental Policy and Planning	Every 6 month	As specified in EIA
	Provincial Industry Offices and municipal government	Monthly	As specified in EIA
Report of Pollution control	Ministry of Industry	Monthly	Quantity of dust, SO_x, NO_X, dioxin from stack emission, workplace air quality and ambient air quality
Report type of waste generated	Ministry of Industry	Annually	Type of waste generated
Report of quantity of waste generated	Ministry of Industry	Annually	Quantity of hazardous and non-hazardous waste
	Provincial Industry Offices	Annually	Quantity of non-hazardous waste
Report of quantity of disposed waste	Provincial Industry Offices and Ministry of Industry	Monthly	Quantity of disposed waste

From the above Table, many the government agencies control the performance of the cement industry's pollution. Environmental regulations are oriented toward the protection of the environment. Therefore, if an organization complies with the regulations, there is a good chance that its environmental performance is at least acceptable.

4.1.6 NGOs

The environmental NGO movement in Thailand is significant. There are over 70 NGOs registered with the Department of Environmental Quality Promotion (DEQP). Thai law grants juristic status to NGOs, and only registered NGOs may request governmental assistance and support for their activities. The environmental

NGOs are involved in a variety of activities ranging from population and community development to natural resource protection and pollution control. Several of these NGOs receive the patronage of the Thai royal family. NGOs also have representation in the National Environmental Board (NEB). One of the well-known organizations is the Thailand Environment Institute (TEI), which plays a catalytic role in coordinating governmental, non-governmental, academic, private sector, media and general public action in relation to environmental management.

However, it was found that most NGOs in Thailand do not have interest in mining and cement operations. The main mission of most NGOs in Thailand are to serve as a respected research institute; a center of high-quality information and meaningful action committed to sustainable human development; a conductor of research activities within and outside the country to benefit the conservation of natural resources and the environment; and a supporter and participant in the practical application of the research findings, establishing up-to-date and reliable information systems and through providing for extensive dissemination of quality information on environmental issues. In line with its social obligations towards the Thai society, NGOs undertake environment related capacity building activities among the more vulnerable groups of society in support of the national poverty alleviation goals and within the overall framework of sustainable development.

4.1.7 Shareholders

In general, shareholders concern about cost, business advantages, and liabilities. As subsidiary of the Siam Cement Group, the plant studied does not have a direct contract with its shareholders. The means for communicating its performance to shareholders is only through general shareholder meetings and reports, i.e. financial reports and sustainable reports, provided by the holding company.

Table 4.4 *First ten major shareholders of the Siam Cement Industry (as of 8 April 2004)*

Shareholder	No. of common share	% of total shares
1. Bureau of the Crown Property.	360,000,000	30.00
2. Thai NVDR Co., Ltd.	112,162,190	9.35
3. State Street Bank and Trust company.	27,542,917	2.30
4. CPD Equity Co., Ltd.	23,202,000	1.93
5. HSBC (Singapore) Nominees Ltd.	17,681,514	1.47
6. Office of The Privy Purse.	15,473,000	1.29
7. Chase Nominees Limited.	15,275,220	1.27
8. Randery Burahmakan Co.,Ltd.	14,810,400	1.23
9. Littledown Nominees Limited.	14,300,000	1.19
10.The Siam Cement Foundation.	13,294,300	1.11

Source: The Stock Exchange of Thailand; http://www2.set.or.th/set/en/company/company_u2.jsp

4.1.8 Management

The organization structure of the Siam Cement Industry Co., Ltd is shown in Figure 4.2

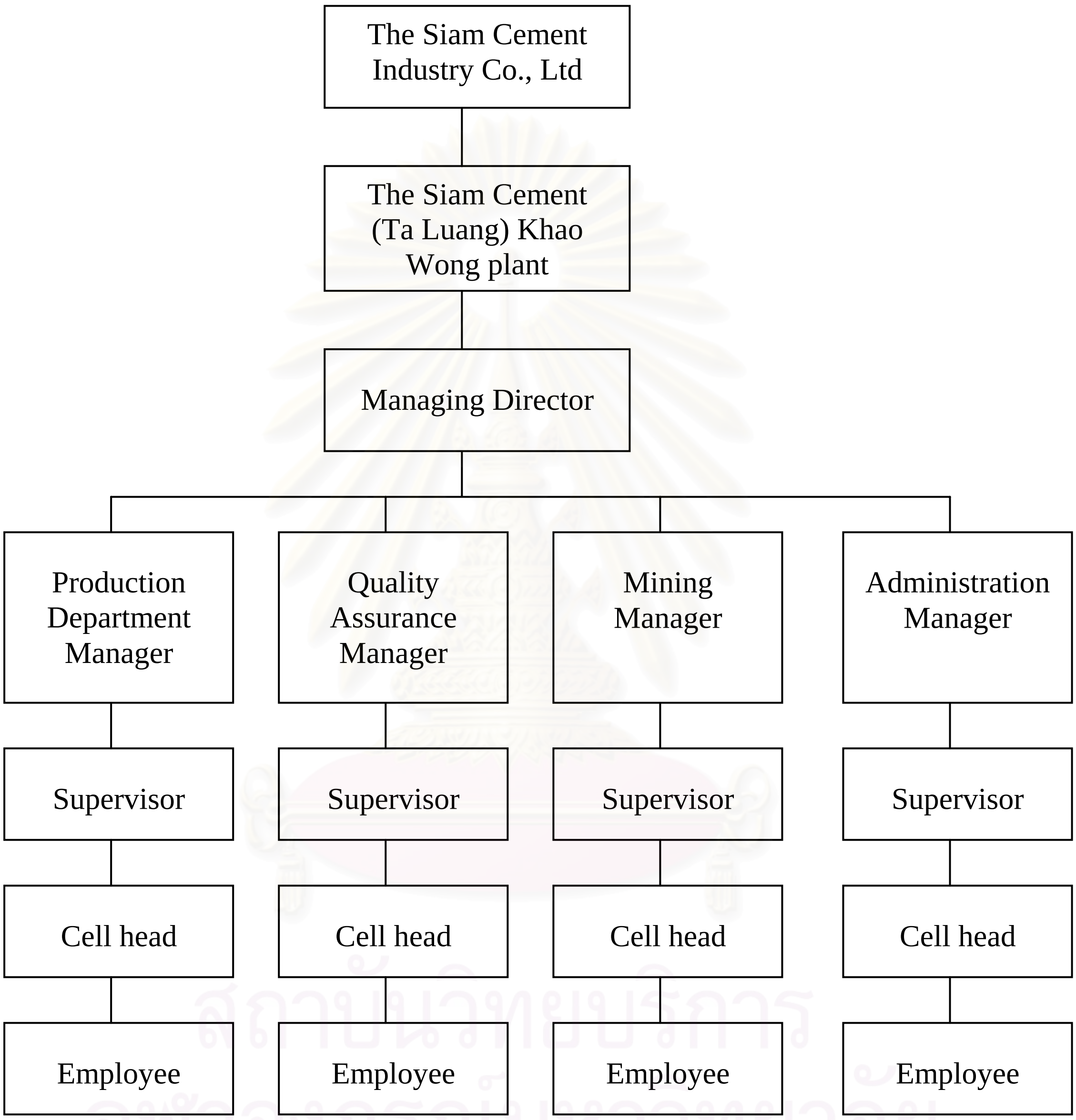


Figure 4.2 *Organization of The Siam Cement Industry*

The Siam Cement Industry company has the policy to continually improve itself to sustain business leadership in Thailand and in the region, while being internationally competitive. Since the Siam Cement Industry is determined to develop the quality of Thai people's life for the betterment and benefit of Thai society, the Siam Cement Industry provides support for the development of education, sports, environment and public welfare. At the same time, the Siam Cement Industry is dedicated to strictly conducting its business in accordance with the concept of good corporate governance to ensure transparency, disclosure, verification, and fairness. This is in harmony with its code of ethics of which can be summarized into "Quality and Fairness."

From the organization chart, the Siam Cement (Ta Luang) Khao Wong plant is under the management of the Siam Cement Public Company Limited. Thus, the environmental policy of the board directors from the Siam Cement Public Company Limited must be practiced by the Siam Cement (Ta Luang) Khao Wong plant. The managing director received the company's environmental vision and policy from the board directors. After that, he established the vision and policy suitable for this plant. Which the division managers practiced by setting the goals, targets, action plans and key performance indicators for each division of the plant.

The survey of the stakeholders' requirements, illustrated various type of stakeholders and their interested in the environmental performance as summarized in Table 4.5

Table 4.5 *Stakeholders of the Siam Cement Industry (Ta luang), Khao Wong Plant and their interests in environmental issues*

Category	Sub-category	Aspect	Stakeholders
Pollution	Emission	Dust	Government, local communities, shareholders, employees and management
		SO_x	Government, employees and management
		NO_x	Government, employees and management
		CO_2	Government, employees and management
		CO	Employees and management
		VOC	Government, employees and management
		Dioxin	Government, employees and management
Environmental condition		Noise	Government, employees and management
		Heat	Government, employees and management
		Trembling	Government, employees and management
Resource consumption	Water	Surface water	Employees and management
		Ground water	Government, local communities, employees and management
	Energy	Electricity	Government, employees, shareholders and management
		Coal	Government, employees, shareholders and management
		Bark and rice husk	Government, employees and management
		Chemical waste	Government, employees and management
	Natural resource	Lime stone	Government, employees and management
		Shale	Employees and management
		Laterite	Employees and management
		Clay	Employees and management
		Gypsum	Employees and management

In brief, the environmental relationships between cement plant and its stakeholders can be described as the diagram in Figure 4.3

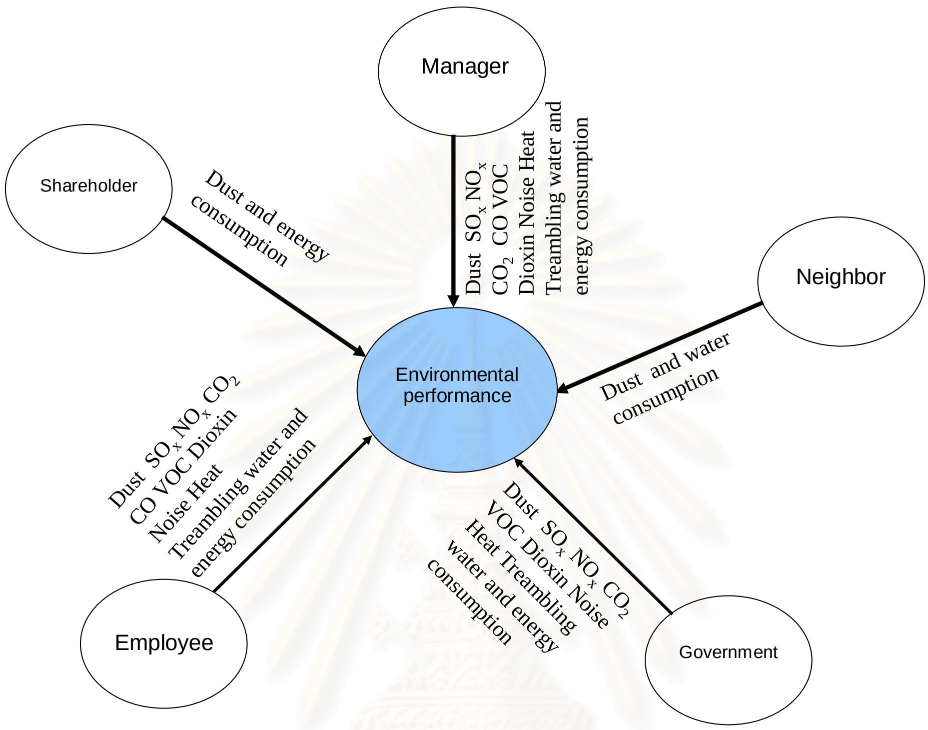


Figure 4.3 *Environmental aspects and relevant stakeholders*

4.2 Assessment of environmental performance

Assessment of environmental performance was performed on the basis of the Plan-Do-Check-Act process.

4.2.1 Planning

a) Identification of significant environmental aspects

In order to evaluate the environmental performance, the portland cement process was reviewed. As shown in the Figure 4.4, the process can be divided into the various steps: mining, raw milling, pyroprocessing, cooling, and cement milling.

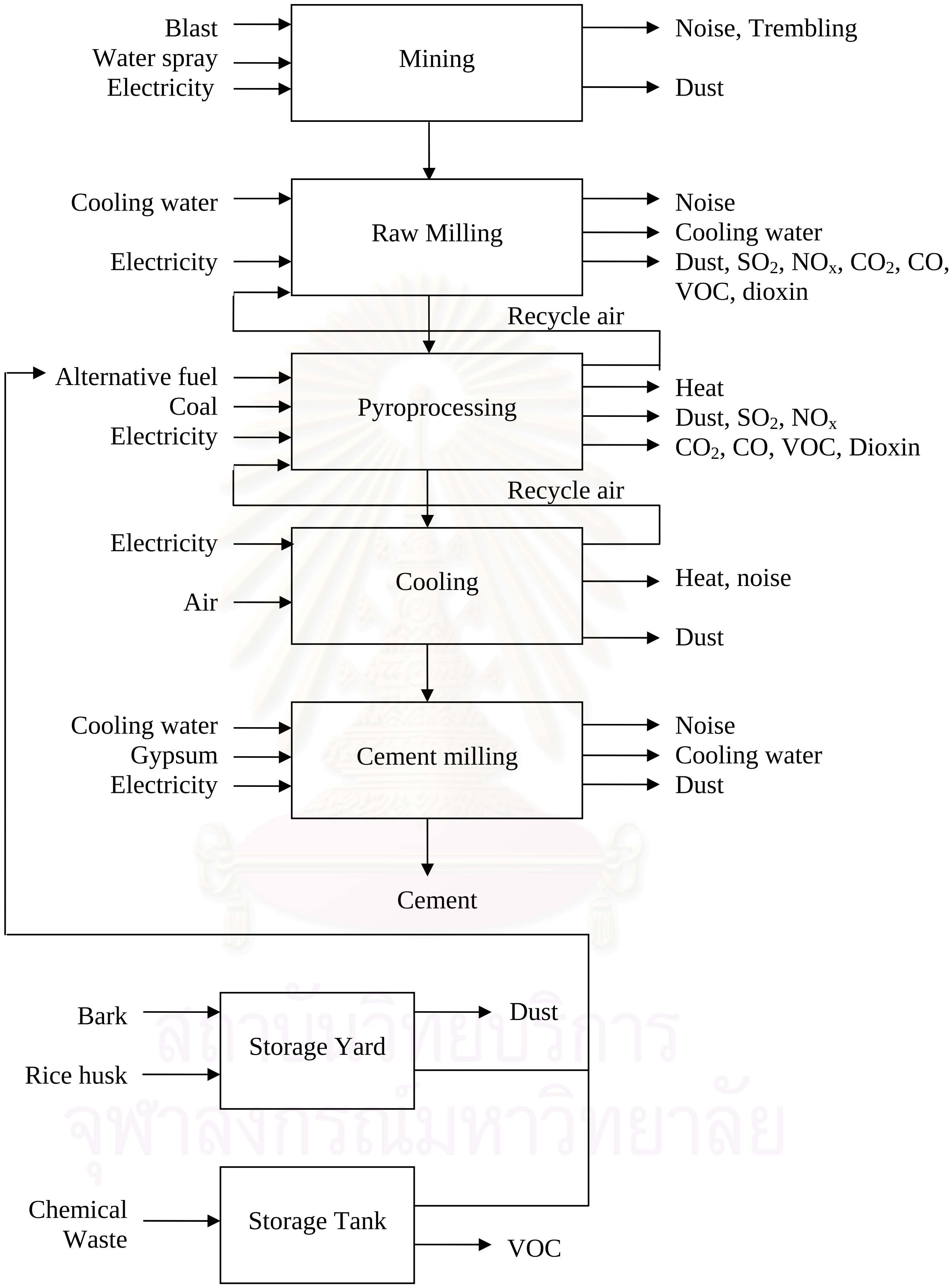


Figure 4.4 *Process diagram of the portland cement process*

The environmental aspects summarized from these processes are illustrated in Table 4.6.

Table 4.6 *Environmental aspects of Portland cement production.*

Category	Sub category	Aspect	Source
Pollution	Emission	Dust	Crushers, raw mills, kiln, clinker cooler, cement mill, road and pavements, conveyor, storage yards
		SO_x	Kiln
		NO_x	Kiln
		CO_2	Kiln
		CO	Kiln
		VOC	Kiln, chemical waste storage
		Dioxin	Kiln
Environmental condition		Noise	Blasting, raw mill, clinker cooler, cement mill, transportation
		Heat	Raw mill, kiln, clinker cooler
		Trembling	Blasting
Resource consumption	Water	Surface water	Crusher (water spray)
		Ground water	Raw mill, kiln, clinker cooler, cement mill
	Energy	Electricity	Mining, raw mill, kiln, clinker cooler, cement mill
		Coal	Kiln
		Bark and rice husk	Kiln
		Chemical waste	Kiln
	Natural resource	Lime stone, shale, laterite and clay	Mining and raw mill
		Gypsum	Cement mill

The approaches to identify significant environmental aspects are:

- Identify the view of interested parties and use this information to establish the criteria.

- Identify the activities of the organization that are subjected to environmental regulation or other requirements, of which, data may have been collected by the organization.
- Analyze the organization's existing data on materials and energy inputs, discharges, wastes, and emissions, and assess these data in terms of impact, and the potential impacts related to risk.

The criteria used to determine the significance of each aspect can be illustrated in Tables 4.7 and 4.8. After, categorizing the environmental aspects, their significance can be seen in Table 4.9.

Table 4.7 *The criteria used to determine the significance of the environmental aspects of the cement plant*

Pollution

Interested Parties	A
Considerable interest (4 - 5 groups)	3
Some interest (1 – 3 groups)	2
No interest (0 groups)	1

Legislation	B
Covered by existing legislation	3
Likely to be covered by future legislation	2
Not a potential legislation	1

Impact	C
High (score of impact = 10 - 27)	3
Medium (score of impact = 4 - 9)	2
Low (score of impact = 1 - 3)	1

Total criteria = A + B + C

score 7 - 9 = significant aspect
score 4 – 6 = interested aspect
score 1 - 3 = not significant aspect

Resource

Interested Parties	D
Considerable interest (4 - 5 groups)	3
Some interest (1 - 3 groups)	2
No interest (0 groups)	1

Legislation	E
Covered by existing legislation	3
Likely to be covered by future legislation	2
Not a potential legislation	1

Environmental Damage	F
High (score of Environmental Damage = 10 - 27)	3
Medium (score of Environmental Damage = 4 - 9)	2
Low (score of Environmental Damage = 1 - 3)	1

Total criteria = D + E + F

score 7 - 9 = significant aspect
score 4 – 6 = interested aspect
score 1 - 3 = not significant aspect

Table 4.8 *The criteria used to determine the impact of pollution and environmental damage*

Pollution	
Severity of Pollution	**G**
Acute toxicity or Chronic toxicity	3
Local toxicity or physical injured	2
No hazardous to human	1

Scale of Impact	H
Global	3
National	2
Local	1

Likelihood	I
Uncontrolled by procedures, monitoring, and preventative measures.	3
Controlled to some extent	2
Well controlled by procedures, monitoring	1

Total criteria = G x H x I

score 10 - 27 = high impact
score 4 - 9 = medium impact
score 1 - 3 = low impact

Resource	
Type of natural resources	**J**
Non renewable resource	3
Renewable resource in short supply	2
Renewable resource, freely available	1

Scale of Impact	K
Global	3
National	2
Local	1

Likelihood	L
Necessary to use, no replaced resource	3
Resource can be replaced but not of equal quality	2
Replaceable resource	1

Total criteria = J x K x L

score 10 - 27 = high environmental damage
score 4 - 9 = medium environmental damage
score 1 - 3 = low environmental damage

Table 4.9 *Significant environmental aspects of Portland cement production*

Category	Sub category	Aspect	Score	Significance level
Pollution	Emission	Dust	8	Significant
		SO_x	7	Significant
		NO_x	7	Significant
		CO_2	7	Significant
		CO	4	Interested aspect
		VOC	5	Interested aspect
		Dioxin	6	Interested aspect
Environmental condition		Noise	6	Interested aspect
		Heat	6	Interested aspect
		Trembling	6	Interested aspect
Resource consumption	Water	Surface water	4	Interested aspect
		Ground water	6	Interested aspect
	Energy	Electricity	6	Interested aspect
		Coal	5	Interested aspect
		Bark and rice husk	4	Interested aspect
		Chemical waste	4	Interested aspect
	Natural resource	Lime stone	6	Interested aspect
		Shale	4	Interested aspect
		Laterite	4	Interested aspect
		Clay	4	Interested aspect
		Gypsum	4	Interested aspect

b) Development of indicator for environmental performance evaluation

From the significant environmental aspects determined previously, the air pollution problems such as dust, sulfur dioxide, oxide of nitrogen and carbon dioxide come first on the list. The impacts on stakeholders may be found both directly and indirectly. The direct impacts regenerated from pollutants receivable by employees and neighborhood communities. Indirect impacts can be realized through business relations such as customer, suppliers, shareholders, and legislative involvement. It can thus be anticipated that variety of expectations regarding environmental performances of a company should be raised. For the cement factory studied, the expectations of various stakeholders are taken into consideration in the process of development of performance indicators as illustrated in Table 4.10.

Table 4.10 *Illustration of environmental performance indicators developed based on stakeholder expectations*

Stakeholder	Expectation	Related information	Environmental performance indicator
Neighborhood communities	• Good environment	• Identification and quantification of pollutants generated by the factory • Degree of environmental impacts related to the pollutants generated • The attempt of the factory in minimizing the environmental impacts	- The quantity of pollutants released - Ambient air quality with reference to the standards - Percentage of the pollution sources that are identified and managed - The effectiveness of environmental management measures

Table 4.10 *Illustration of environmental performance indicators developed based on stakeholder expectations (Cont.)*

Stakeholder	Expectation	Related information	Environmental performance indicator
Employee	• Good working environment	• Identification and quantification of pollutants generated by the factory • Degree of workplace hazardous related to the pollutants generated • The attempt of the factory in minimizing the environmental impacts	- The quantity of pollutants released - Workplace air quality and personal exposure levels with reference to the standards - Percentage of the pollution sources that are identified and managed - The effectiveness of environmental management measures
Government	• Effective implementation and enforcement of regulations	• Identification and quantification of pollutants generated by the factory • Degree of workplace hazardous related to the pollutants generated	- The quantity of pollutants released - Workplace air quality and personal exposure levels with reference to the standards

Table 4.10 *Illustration of environmental performance indicators developed based on stakeholder expectations (Cont.)*

Stakeholder	Expectation	Related information	Environmental performance indicator
Government	• Strengthening of environmental quality	• Degree of environmental impacts related to the pollutants generated	- Ambient air quality with reference to the standards
Shareholder	• Long-term shareholder values	• Avoidance of unnecessary penalty and tax or risk to company's reputation	- Degree of compliances - Penalty and fine
Management	• Satisfaction of stakeholders' expectations	• Identification and quantification of pollutants generated by the factory	- The quantity of pollutants released
		• Degree of workplace hazardous related to the pollutants generated	- Workplace air quality and personal exposure levels with reference to the standards
		• Degree of environmental impacts related to the pollutants generated	- Ambient air quality with reference to the standards
		• The attempt of the factory in minimizing the environmental impacts	- Percentage of the pollution sources that are identified and managed - The effectiveness of environmental management measures
		• Evidences of unsatisfactions	- Penalty and fine

Table 4.11 re-states once again the contributions of stakeholder concerns on the environmental performance development.

Table 4.11 *Environmental performance indicators corresponding to the expectations of stakeholders*

Environmental performance indicator	Unit	Neighbor hood community	Employee	Government	Shareholder	Management
Percentage of pollution sources identified and managed	%	/	/			/
Effectiveness of environmental management measures	%	/	/			/
The quantity of pollutants released - Absolute emission	ton emission/year	/	/	/		/
- Specific emission	kg emission/ton production		/			/
Workplace air quality	mg/m^3		/	/		/
	Degree of compliance (%)		/	/	/	/
Ambient air quality	mg/m^3	/		/		/
	Degree of compliance (%)	/		/		/
Personal exposure level of emission	mg/m^3		/	/		/
	Degree of compliance (%)		/	/	/	/
Complaints	Number					/
Penalty and fine	Baht				/	/

All indicators developed in this study can then be reassembled into two main groups: management and operation performance indicators, for being in line with ISO standardization as shown in Table 4.12

Table 4.12 *Recommended environmental performance indicators for cement production.*

Category	Sub-category	Performance indicators	Unit
Management performance	Management inclusiveness	Percentage of pollution sources identified and managed	%
	Management effectiveness	Effectiveness of environmental management measures	%
Operation performance	Direct impact	The quantity of pollutants released - Absolute emission - Specific emission	ton emission/year kg emission/ton production
		Workplace air quality	mg/m^3
			Degree of compliance (%)
		Ambient air quality	mg/m^3
			Degree of compliance (%)
	Indirect impact	Personal exposure level of emission	mg/m^3
			Degree of compliance (%)
		Complaints	Number
		Penalty and fine	Baht

Explanations for management performance indicators

Management performance indicator provides information on management's efforts made to minimize the environmental impacts associated with its business activities. The subcategory indicators are:

- Subcategory : Management inclusiveness

The management inclusiveness indicator is used to evaluate the degree (as percentage) of problem sources being identified and managed. It is clear that this indicator gives an idea of the degree of concern of management regarding environmental issues.

There are a number of management tools that complement and strengthen the process of problem identification and management such as cleaner technology, ISO 14001, etc. It has therefore been assumed in many instances that the company opting the above standards is doing fine with this inclusiveness aspect. Nonetheless, the quantification of such understanding is obviously more useful for the performance evaluation.

- Subcategory : Management effectiveness

The management effectiveness indicator shows how well the management handles the environmental problems. In this study, four components of effective management are proposed. They are appropriateness, coverage of practice, audit system, and corrective action.

The appropriateness concerns both technology and strategy used by the management to manage the problems. It is should thus be the first criteria for the start of effectiveness determination. In term of the practice of management tools, it is likely that variety of the degree of implementation can be encountered. The coverage of practice is proposed to reflect this aspect of effectiveness.

Thirdly, the effectiveness of any measures can not be assessed without evaluation or auditing system. It is expected that the company implementing thorough auditing system can manage the problems better. After the management realizes the effectiveness of its implementation, the corrective action should be addressed to further enhance the effectiveness.

By taking all four components together, the multiplication of all components as presented in Table 4.13 is used because these components are not independent of each other.

Table 4.13 *The criteria used to determine the implementation effectiveness*

Effectiveness

Appropriateness	A
Advance technology, suitable method	3
General technology, general method	2
Poor technology, awkward method	1

Coverage of practice	B
>80% of source operate	3
50-80% of source operate	2
<50% of source operate	1

Audit system	C
Preventive maintenance and daily check	3
Preventive maintenance	2
No audit system	1

Corrective action	D
Machine class A, rapidly correct before operation shutdown or active corrective plan	3
Machine class B, the process can operate with out this machine thus slowly correct or fair corrective plan	2
No corrective plan	1

Total criteria = AxBxCxD

$$\% \text{ Effectiveness} = \frac{(AxBxCxD)}{81} \times 100$$

Explanations for operation performance indicators

Operational performance indicators are a type of EPI, and they provide management with information on the environmental performance of the organization's operations. The OPI deals primarily with the technical type of operational activities such as operation of equipment, discharges, and the use of the product or service. The subcategory operation performance indicators are:

- Subcategory : Direct impact

The operational performance indicator were direct impact that the delivery of outputs resulting from the organization's operations. The emphasis is on the EPI that measures activity and action versus planning and tracking with the management system. The direct impact indicators are used to evaluate the quantity of emission both absolute and specific emission that emit to the environment. It can be represented by the quantity of emission from stack emission. The units of these indicators are ton emission per year and kg emission per ton production. Weights are assigned for each impact. The weights are a measure of the relative importance of the impact on a global scale. The weights should be roughly the same for similar products. The weights may have to be adjusted, however, for different products and possibly for drastically different part of the world. The weights are the first things to determine.

The emission is released from a factory that has a direct affect to employee and neighbor. The indicators evaluate the impact that employee and neighbor received were workplace air quality, and ambient air quality. The units of these indicators are concentration of pollution (mg/m^3) and degree of compliance (%). The concentration of pollution show the actual impact that people received and the degree of compliance show the performance of factory that met the standard.

- Subcategory : Indirect impact

The operational performance indicators were indirect impact that can not get directly. The indicator evaluated personal exposure level of emission, complaints, and penalty and fine. The indicators show to arrive at the effects that receive from operation of this factory.

The units of personal exposure level of emission are concentration of pollution (mg/m^3) and degree of compliance (%).The concentration of pollution show the actual impact that people received and the degree of compliance show the performance of factory that met the standard.

The unit of complaints from stakeholder is number of complaints. Divide to follow a kind of stakeholder. The last of indirect impact indicator is penalty and fine from complaints of stakeholder. Which happen because of, a factory must be fined because make a mistake the agreement.

4.2.2 Performance assessment (DO)

4.2.2.1 Environmental performance related to dust emissions

The emission of dust depends greatly on the product being made, production capacity, plant age and facilities, including the emission control system installed. Dust is generated through stack emissions, handling, spillage, leakages, and in other processes at every stage of cement manufacturing, starting with the quarrying of the major raw material, limestone, and ending with the packing of cement from the plant. The source of dust emission can be broadly divided into point sources and fugitive sources.

"Point source" dust emissions originate mainly from the raw mills, the kiln system, the clinker cooler and the cement mills. These emissions are controlled using electrostatic precipitators and bag filters. In this cement plant, there are nine stacks and one hundred and thirty-one bag filters.

"Fugitive" dusts from dispersed sources around the plant area come from various activities such as material handling, storage, and transportation. Two areas of environmental performance evaluation were carried out as follows:

A. Management performance

A.1 Management inclusiveness

Indicator is represented by the percentage of dust emission sources controlled or managed to the total number of sources.

Table 4.14 *Dust emission sources and related control systems*

Significant aspect	Type	Source	Control system
Dust	Point source	Mill-stone building, kiln, lignite mill, raw mill, cement mill	Electrostatic precipitator, and bag filters
	Fugitive source	Blasting	Bag filler in drill-car and semi-open cut mining
		Loading	The tree cultivated for wind break
		Unloading	Water spray and installation of curtains at crusher's loading bag
		Crushing	Cover crusher
		Conveyor transfer	Closed building and cover for outside building transfer section
		Piling	Drop height adjustment and cover pile
		Road	Water spray on the road, sweep the road, speed limit and design slope of road

It can be seen that, at the plant studied, all sources of dust have been well identified and at least one control measure has been implemented for each source. The 100% mark can thus be given for management inclusiveness on dust emission issue.

A.2 Management effectiveness

The indicator in this category evaluated the effectiveness of management performance at each source of dust emission. The indicator of management effectiveness is the percentage of implementation effectiveness. Table 4.15 shows the effectiveness results of the dust control emission source.

Table 4.15 *Effectiveness of the dust emission control at sources in the cement plant*

Source	Measure	Appropriateness	Coverage of practice	Audit system	Corrective action	% Effectiveness
Point source	Electrostatic precipitator	3/3 *The best technology of dust emission*	3/3 *Cover all processes*	3/3 *Preventive maintenance and daily check*	3/3 *Machine class A*	100.0
	Bag filter	3/3 *Suitable for conveyor transfer*	3/3 *Cover all the process*	3/3 *Preventive maintenance and daily check*	2/3 *Machine class B*	66.7
Blasting	Bag filler in drill-car	3/3 *The best technology of drill-car*	3/3 *80% of drill-car*	3/3 *Preventive maintenance and daily check*	2/3 *Machine class B*	66.7
	semi-open cut mining	3/3 *the most advanced open-mining*	3/3 *Cover all the mining*	3/3 *Audit by engineer of mining*	3/3 *Corrective plan of mining*	100.0
Loading	The tree cultivated for windbreak	2/3 *The general technology of shelter*	2/3 *Not enough trees*	1/3 *Lack of audit system*	1/3 *No corrective plan*	4.9

Table 4.15 *Effectiveness of the dust emission control at sources in the cement plant(Cont.)*

Source	Measure	Appropriateness	Coverage of practice	Audit system	Corrective action	% Effectiveness
Unloading	Installation of curtains at crusher's loading bay	2/3 *The general technology of dust reduction*	3/3 *Cover all the process*	3/3 *Preventive maintenance*	2/3 *Machine class B*	44.4
	Water spray	2/3 *The general technology of dust reduction*	3/3 *Cover all the process*	3/3 *Preventive maintenance*	2/3 *Machine class B*	44.4
Crushing	Cover crusher	2/3 *The general technology of dust reduction*	3/3 *Cover all the process*	3/3 *Preventive maintenance*	2/3 *Machine class B*	44.4
Conveyor transfer	Closed building and underground transfer line	3/3 *Best available*	3/3 *Cover all the process*	3/3 *Audit not required*	3/3 *Fail proof*	100.0
	Cover for on-ground transfer section	3/3 *Best practical*	3/3 *Cover all the process*	3/3 *Preventive maintenance*	2/3 *Machine class B*	66.7
Piling	Drop height adjustment	3/3 *Suitable for piling*	3/3 *Cover all the process*	3/3 *Preventive maintenance*	2/3 *Machine class B*	66.7
	Cover pile	3/3 *Suitable for piling*	1/3 *30% of pile in open area*	1/3 *inspection*	2/3 *Machine class B*	7.4
Road	Water spray on the road	2/3 *Suitable for fugitive emission*	2/3 *Cover all the un-concrete road*	1/3 *Lack of audit system*	2/3 *Machine class B*	9.9
	Sweep the road	2/3 *Suitable for fugitive emission*	3/3 *Cover all the road*	1/3 *Lack of audit system*	1/3 *No corrective plan*	7.4
	Speed limit	2/3 *Suitable for fugitive emission*	3/3 *Cover all the plant*	1/3 *Lack of audit system*	1/3 *No corrective plan*	7.4

Table 4.15 *Effectiveness of the dust emission control at sources in the cement plant(Cont.)*

Source	Measure	Appropriateness	Coverage of practice	Audit system	Corrective action	% Effectiveness
Road	Design slope of road	3/3 *Suitable for reduce accumulate dust on road*	3/3 *Cover all the concrete road*	1/3 *Lack of audit system*	1/3 *No corrective plan*	11.1

It can be seen that for each method; the effectiveness of the control dust emission source at the plant studied had different level of efficiency. The most effective method to reduce dust emissions was the electrostatic precipitator while the tree cultivation for windbreak protection is least effective because the tree are not provide for being a good shelter; lack of an audit; and no corrective plan.

B. Operational performance

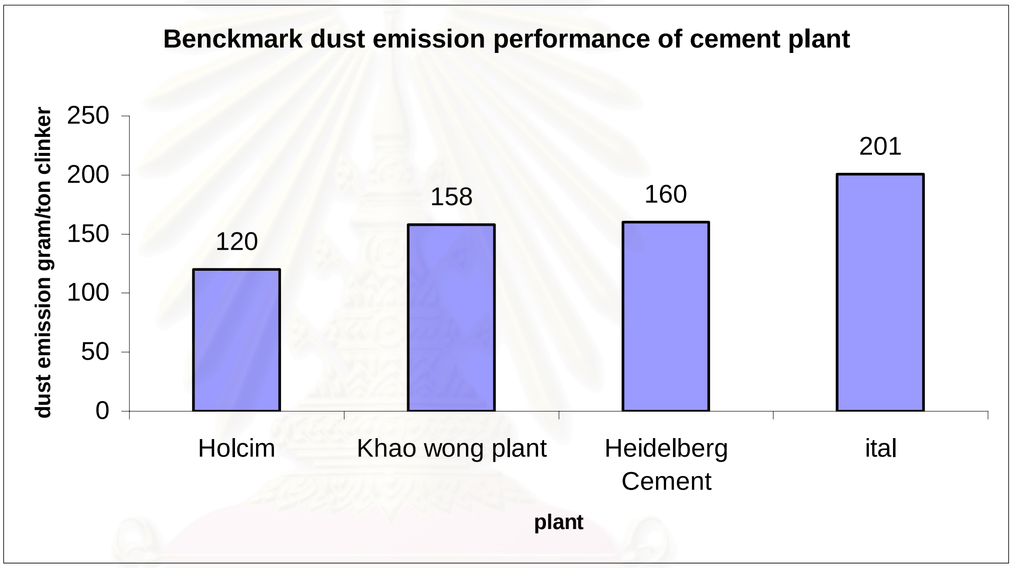
B.1 Direct impact

The indicator in this category is used to evaluate the quantity of dust emissions, both absolute and specific emissions, that are emitted to the environment. It can be represented by the quantity of dust from stack emission, workplace air quality and ambient air quality. Table 4.16 shows the absolute and specific dust emissions from the stacks. The benchmark of dust emission performance is shown in Figure 4.5.

Table 4.16 *Absolute and specific dust emissions from the stacks of cement plant*

Significant aspect	Source	Type	ton emission/year	g emission/ton clinker
Dust	Electrostatic precipitator	Operation	460.4	148.5
		Trip	33.0	9.5
	Bag filter	Operation	262.0	75.3
	Total		755.4	233.3

Figure 4.5 *Comparison of dust emission from the stacks of the Khao Wong plant with other cement companies*



According to the environmental performance of the Siam Cement Industry Ta-luang, Khao Wong factory, the amount of emission that remains goes over the best practice of the others countries, especially for dust. From the study, Holcim generated less dust through the use of continuous emission monitoring system (CEMs). The system produced emission results continually and created the maximum accepted value of emission dust. Moreover, it could control the emission value until the operation of electrostatic precipitators stopped. As a result, electrostatic precipitators' trip rarely occurred and as a result, the effluent dust volume was less.

Another direct impact can be quantified from the dust concentration in the workplace. The indicators of workplace air quality are divided into the degree of compliance and the average quality. For effective management, it is beneficial to separate the performance evaluation into areas of different activities, i.e. mining, office of cement plant, raw mill, cement mill, packing, and lignite mill. Table 4.17 shows the degree of compliance with regard to dust emissions in the workplace and Table 4.18 shows the average values of air quality in each workplace area at this cement plant. The performance of dust in the workplace is concluded in Figure 4.6.

Table 4.17 *Degree of compliance of dust emission (%) in the workplace*

Operation	No. of sample	No. of noncompliance	Degree of compliance (%)
Mining	13	1	92.3
Office	8	0	100.0
Raw mill	2	0	100.0
Cement mill	4	1	75.0
Packing	31	1	96.8
Lignite mill	9	2	77.8

Table 4.18 *Average dust emission in each workplace area*

Operation	Average dust emission in workplace (mg/m^3)	Standard average dust emission in workplace (mg/m^3)
Mining	1.8	≤ 15
Office	0.6	≤ 15
Raw mill	0.3	≤ 15
Cement mill	35.2	≤ 15
Packing	2.2	≤ 15
Lignite mill	15.4	≤ 15

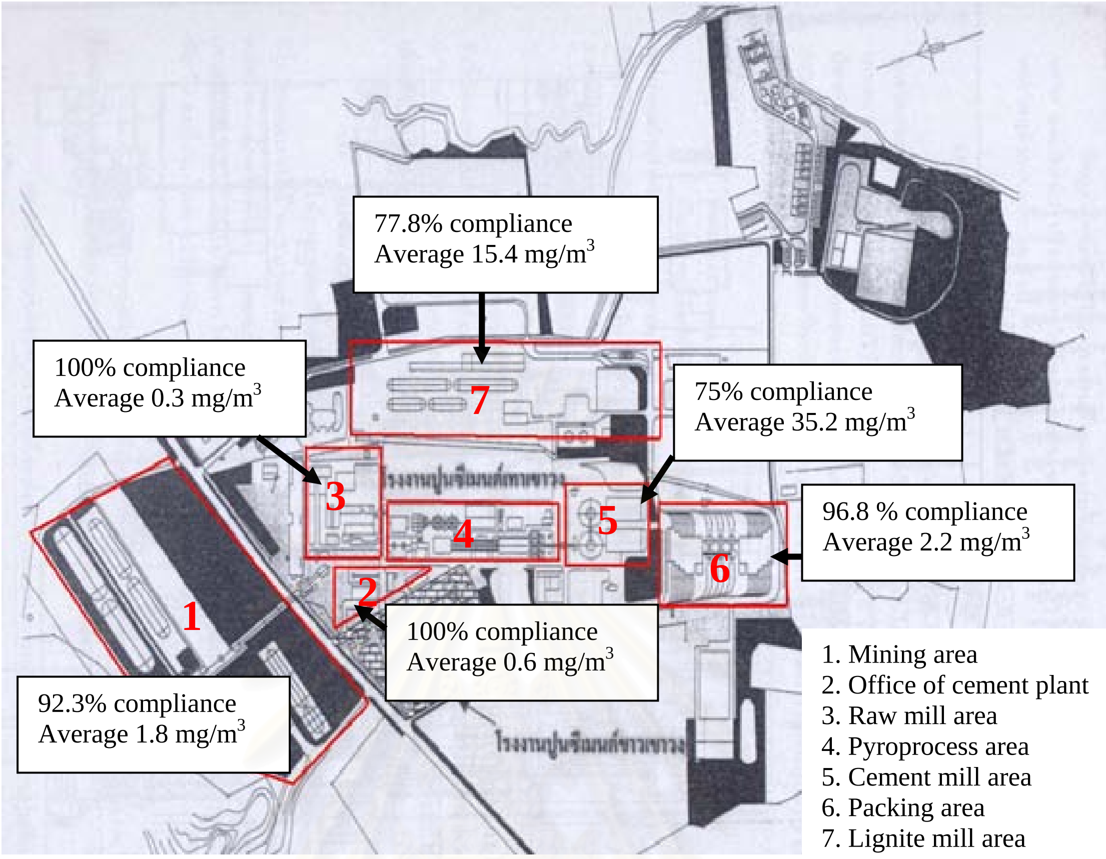


Figure 4.6 *The performance of dust emission in the workplace*

The direct impact indicator also included the dust quantity; in ambient air, the indicators of ambient air quality were the percentage of the compliance area and the average quality. Table 4.19 shows the percentage of community area passing the compliance dust emission in ambient air quality and Table 4.20 shows the average value of air quality in this area. The performance of dust in ambient air quality is concluded in Figure 4.7.

Table 4.19 *the degree of compliance of dust emission (%) in ambient air*

Source	No. of Sample	No. of noncompliance	Degree of compliance (%)
Bahn Ngaung Pah Pong	7	0	100.0
Employee lodging	7	0	100.0
Bahn Kow Wong	7	0	100.0
Bahn Woong	7	1	85.7
Nah Pra Lahn school	7	0	100.0
Bahn Muang Fai	7	0	100.0

Table 4.20 *Average of dust emission in ambient air*

Operation	Average dust emission in ambient air (mg/m^3)	Standard average dust emission in ambient air (mg/m^3)
Community of Khow Wong plant	0.13	$\leq$ 0.33

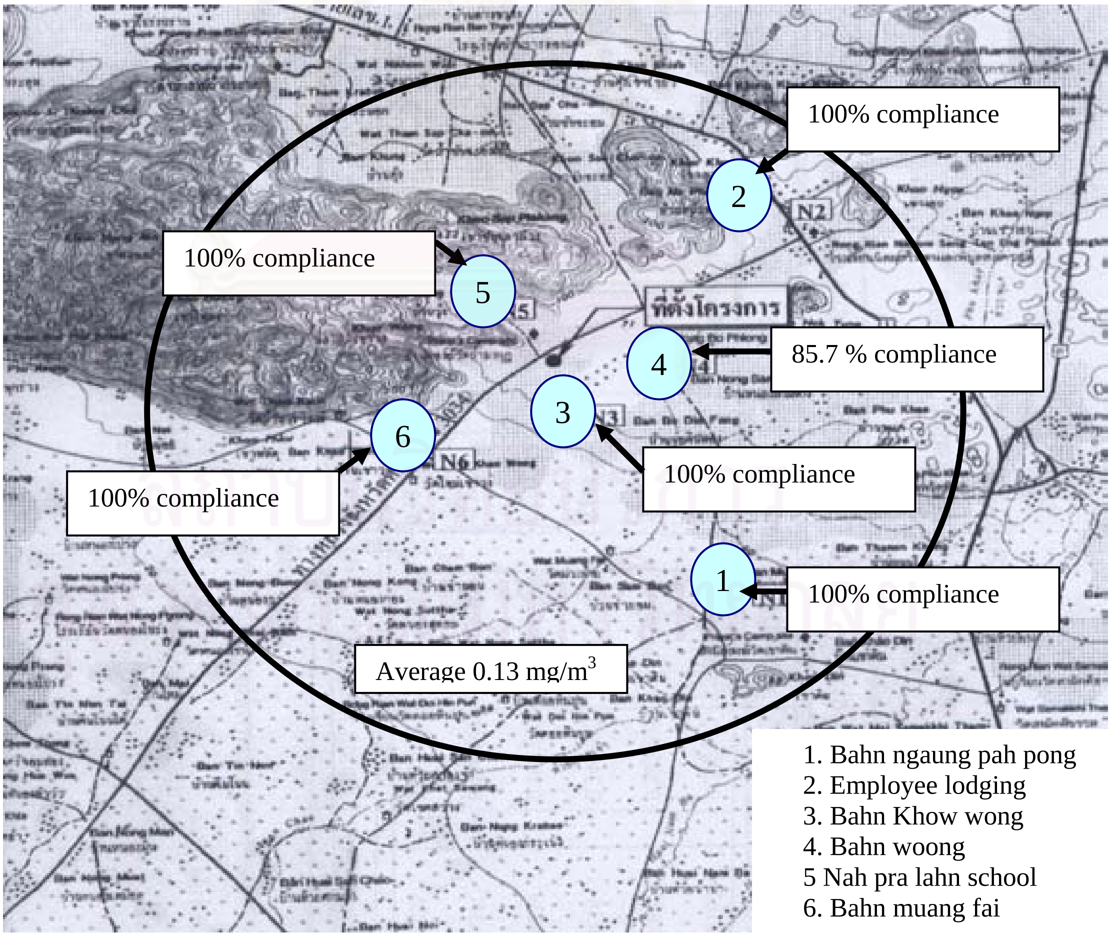


Figure 4.7 *The performance of dust emission in ambient air*

B.2 Indirect impact

The indicator in this category is used to evaluate the exposure level of dust emissions that an employee can receive while working and the complaints of stakeholders on the issue of dust emissions. Table 4.21 shows the percentages of area pass compliance with the dust emission in exposure level standard and Table 4.22 shows the average of exposure level in this area. The performance of the exposure level of dust emission can conclude in the figure 4.8.

Table 4.21 *the degree of exposure level dust emission compliance (%)*

Source	No. of Sample	No. of noncompliance	Degree of compliance (%)
Raw mill	2	0	100.0
Kiln	2	0	100.0
Cement mill	2	0	100.0
Lignite mill	2	0	100.0
Packing	4	0	100.0

Table 4.22 *Average exposure levels*

Operation	Average of respirable dust (mg/m^3)	Standard of respirable dust (mg/m^3)
Raw mill	0.22	≤ 5
Kiln	0.05	≤ 5
Cement mill	0.15	≤ 5
Lignite mill	0.47	≤ 5
Packing	0.07	≤ 5

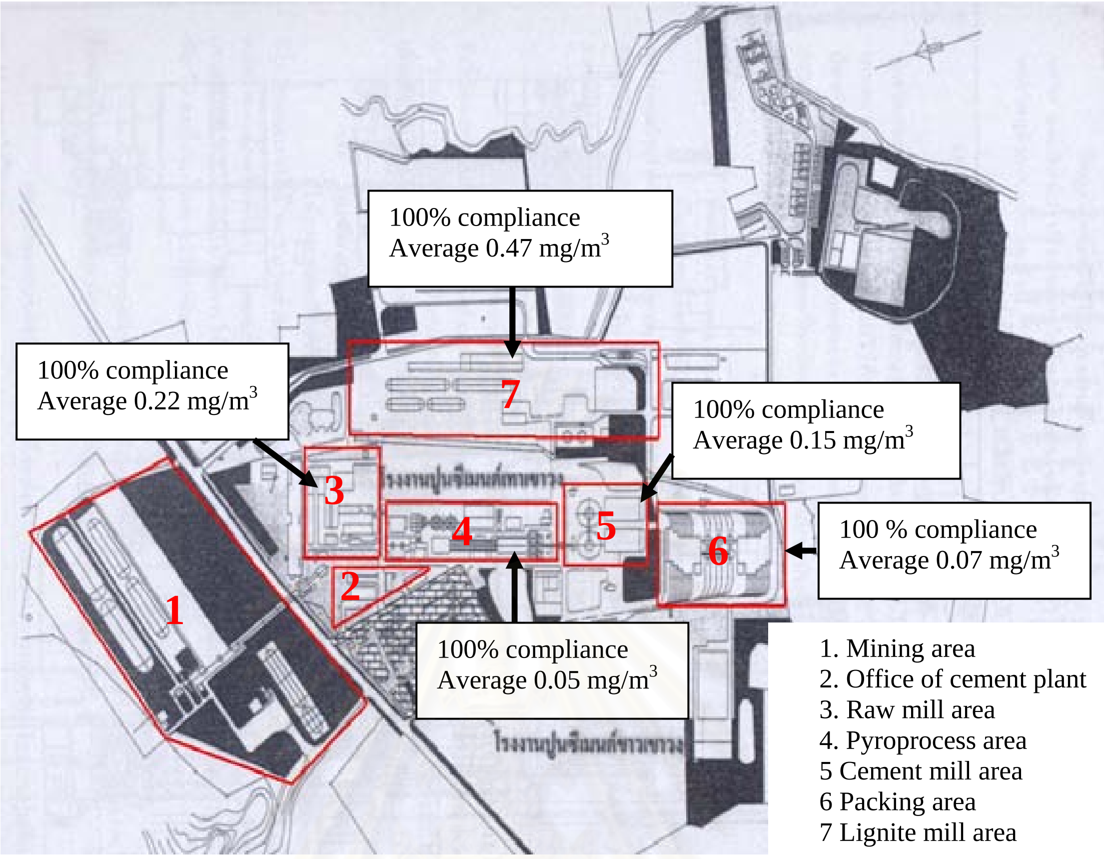


Figure 4.8 *The performance of dust emission exposure levels*

Next indirect impact indicator are the issue and number of complaints from stakeholder. Table 4.23 shows the Complaints of stakeholder (number) and penalty and fine from cement plant.

Table 4.23 *Complaints of stakeholder (number)and penalty and fine from cement plant*

Significant aspect	Stakeholder	Number	Detail	Penalty and fine (baht)
Dust	Neighbor	1 time	Paddy husk dust	0
	Employee	0		0
	Management	0		0
	Government	0		0
	Sharholder	0		0

Dust arises as part of the quarrying process, as well as during grinding, burning, filling, loading, and shipping. Modern electric precipitators and fabric filters are used at this plant to clean the dust-bearing exhaust air. In 2004, the amount of emission could be considerably due to the 233 g emission/ton clinker. Performances of stack emission meet the standard of the PCD. The Most performance of average dust emission in the workplace meets the standards of Ministry of Industry, except for the cement mill and lignite mill areas, which are over the standard. The Most performance of average dust emission in ambient air meet the standard of the PCD, except for Bahn Wong, it's emission in ambient air is over the standard. In the direct impact assessment, the employees and neighbors have a low impact from cement operations.

4.2.2.2 Environmental performance related to sulfur dioxide emissions

Sulfur dioxide (SO_2) emission contributes to acidification and local air pollution, causing harm to human health and the environment. Emissions of SO_2 from cement manufacturing originate sulfur contaminated in fuel. Thus SO_2 emissions can be controlled by appropriate fuel source selection. Sulfur released by the combustion of fuel in the kiln is largely incorporated into the clinker but to a lesser extent in the precalciner. Another source of sulfur dioxide emission comes from diesel fuel used in the truck. Two areas of environmental performance evaluation are carried out as follows:

A. Management performance

A.1 Management inclusiveness

It is represented by the percentage of sulfur dioxide emission sources controlled or managed to the total number of sources.

Table 4.24 *Sulfur dioxide emission sources and related control systems*

Significant aspect	Type	Source	Control
SO_x	Process	kiln	Percentage of sulfur in fuel
	Traffic	Truck	The trucks certified by the department of land transport

All sources of sulfur dioxide have been well identified and control measures have been implemented for each source. The 100% mark can thus be given for management inclusiveness on the sulfur dioxide emission issue.

A.2 Management effectiveness

The indicator of management effectiveness is the percentage of implementation effectiveness. The calculated effectiveness used the criteria in Table 4.13, and Table 4.25 shows the effectiveness result of sulfur dioxide emission source control.

Table 4.25 *Effectiveness of the sulfur dioxide emission control at sources in the cement plant*

Source	Measure	Appropriateness	Coverage of practice	Audit system	Corrective action	% Effectiveness
Process	Percentage of sulfur in fuel	3/3 *Suitable method, reduce source*	3/3 *raw material control*	3/3 *Audit by Quality control supervisor*	3/3 *Penalty*	100.0
Traffic	The trucks certified by the department of land transport	2/3 *The general method*	3/3 *Regulated by the department of land transport*	1/3 *No audit*	1/3 *No corrective plan*	7.4

With regard to the effectiveness of the control of sulfur dioxide emission sources, at the plant studied, each method had different efficiency level. The most effective of reducing sulfur dioxide emissions was control the percentage of sulfur in fuel. While, the method of least effectiveness was the control of the trucks certified by the Department of Land Transport.

B. Operating performance

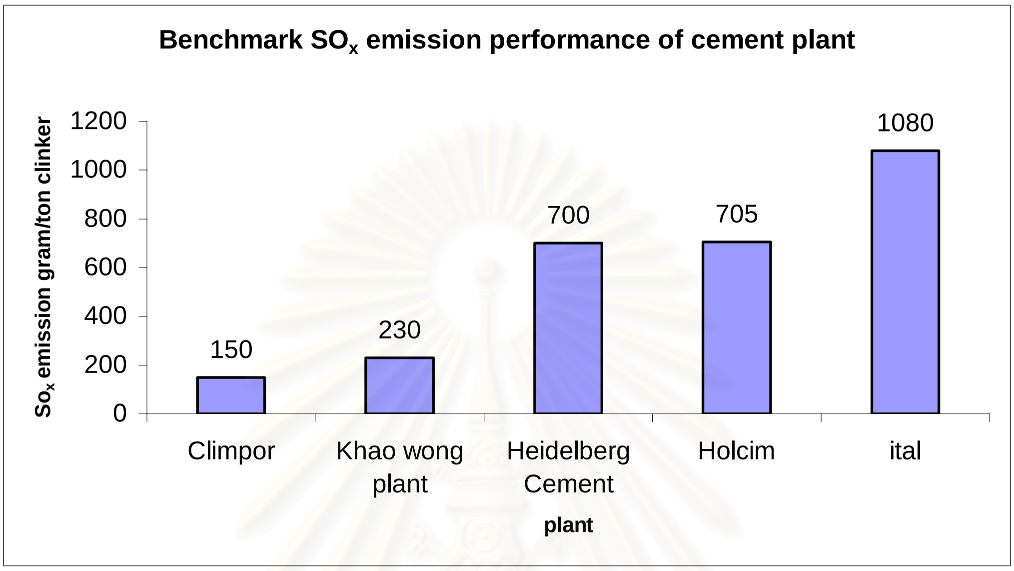
B.1 Direct impact

The indicator in this category is used to evaluate the quantity of sulfur dioxide emission, both absolute and specific emissions, that is emited to the environment. It can be represented by the quantity of sulfur dioxide from stack emission and ambient air quality. Table 4.26 shows the sulfur dioxide emission from stack both absolute and specific emissions. The benchmark of SO_x emission performance is shown in Figure 4.9.

Table 4.26 *Absolute and specific sulfur dioxide emission from the stacks of cement plant*

Significant aspect	Source	ton emission/year	g emission/ton production
SO_x	Process	81.0	230.00
	Traffic	0.2	0.06
	Total	81.2	230.06

Figure 4.9 *Comparison of sulfur dioxide emission of the Khao Wong plant with other cement companies*



In others cement plants such as Climpor, the reduction SO_x emissions is achieved by optimizing kiln operating conditions and controlling raw materials and fuel chemistry through secondary measures such as lime injection.

The next direct impact indicator was the quantity of sulfur dioxide in ambient air quality, the indicators of ambient air quality were the percentage of compliance area and the average quality. Table 4.27 shows the percentage of compliance of the community area with regard to sulfur dioxide emissions in ambient air quality and Table 4.28 shows the average of air quality in the area. The performance of sulfur dioxide in ambient air quality is concluded by Figure 4.10.

Table 4.27 *the degree of compliance of sulfur dioxide emission (%) in ambient air*

Source	No. of Sample	No. of noncompliance	Degree of compliance (%)
Bahn Ngaung Pah Pong	7	0	100.0
Employee lodging	7	0	100.0
Bahn Kow Wong	7	0	100.0
Bahn woong	7	0	100.0
Nah Pra Lahn school	7	0	100.0
Bahn Muang Fai	7	0	100.0

Table 4.28 *Average of sulfur dioxide emission in ambient air*

Operation	Average SO_x emission in ambient (mg/m^3)	Standard average SO_x emission in ambient (mg/m^3)
Community of Khow Wong plant	0.01	$\leq$0.12

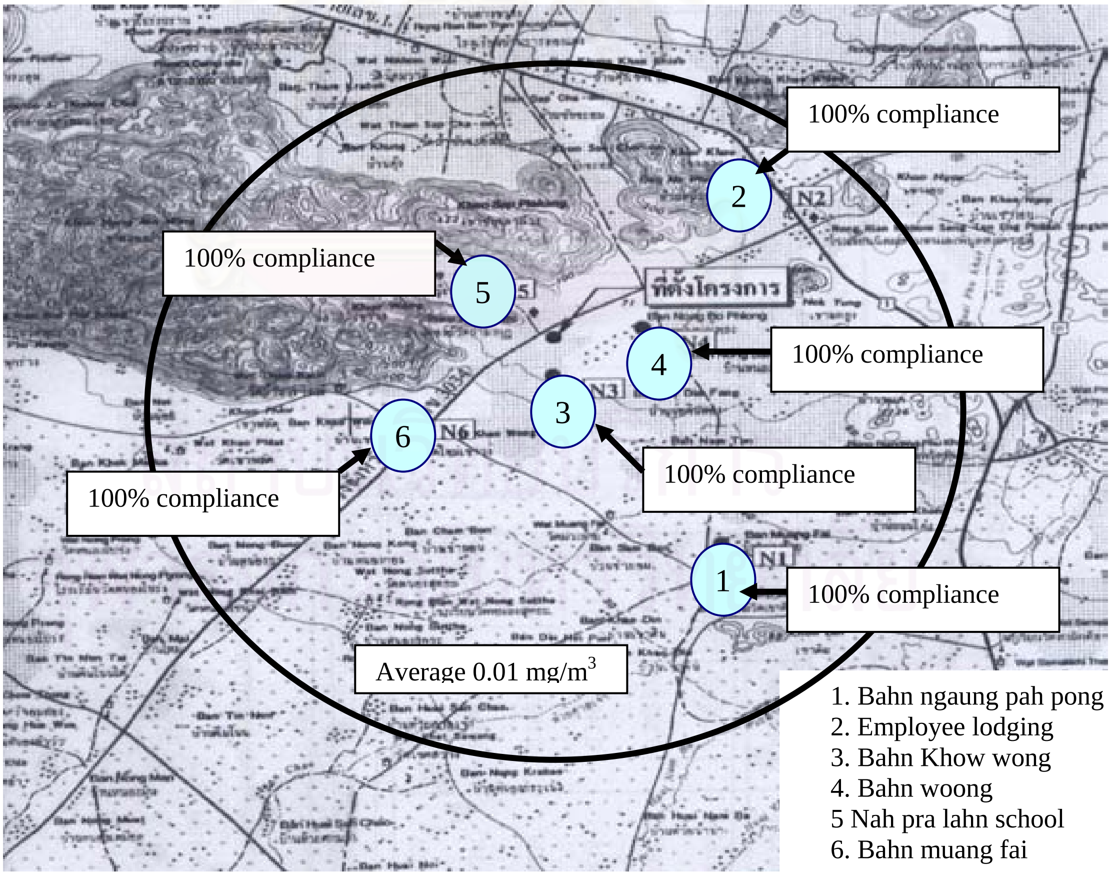


Figure 4.10 *The performance of sulfur dioxide emission in ambient air*

Sulfur dioxides (SO_x) can be formed during the clinker production process. Sulfur is often introduced into the kiln with raw material. Certain sulfur compounds in raw material can lead to increased emissions of SO_x. This cement plant reduced the SO_x emissions by controling the sulfur compound in the fuel and the proper of maintenance the truck. The performance for sulfur dioxide emission at this plant is 230 g emission per ton of clinker. Performances of stack emission met the standard set by the PCD.

4.2.2.3 Environmental performance related to oxide of nitrogen emissions

NO_x are in part responsible for the photochemical smogs that occur over urban areas. NO_x emissions >95% in the form of NO and <5% in the form of NO_2, are a consequence of the high combustion temperatures in cement kilns (approx. 2000°C in the flame zone). Small contributions also come from nitrogen contained in the fuels.

NO_x emissions contribute to the acidification and local air pollution, causing harm to human health and the environment. So, the performance of emissions are concerned with their effective management and impact to the environment. Another source of oxide of nitrogen emission comes from diesel fuel from trucks traveling to and from this plant. Two areas of environmental performance evaluations were carried out as follows:

A. Management performance

A.1 Management inclusiveness

It is represented by the percentage of oxide of nitrogen emission source that is controlled or managed to the total number of sources.

Table 4.29 *Oxide of nitrogen emission sources and related control systems*

Significant aspect	Type	Source	Control
NO_x	Process	Calciner	Low NO_x burner
		Kiln	Control temperature in kiln
	Traffic	Diesel truck	The trucks certified by the Department of Land Transport

The performance of management inclusiveness is 100 % for the control of the main source of emission.

A.2 Management effectiveness

The indicator of management effectiveness is the percentage of implementation effectiveness. The calculated effectiveness used the criteria in Table, 4.13 and Table 4.30 shows the effectiveness result of the oxide of nitrogen control emission source.

Table 4.30 *Effectiveness of the oxide of nitrogen emission control at sources in the cement plant*

Source	Measure	Appropriate ness	Coverage of practice	Audit system	Corrective action	% Effecti veness
Process	low NO_x burner	3/3 *Advance technology*	1/3 *It is usable not every burner*	3/3 *inspection*	3/3 *Machine class A*	33.3
	Control temperature in kiln	2/3 *Suitable method, reduce NO_x generate*	3/3 *Control all process*	3/3 *inspection*	3/3 *Machine class A*	66.7
Traffic	The trucks certified by the department of land transport	2/3 *The fair method*	3/3 *Regulated by the department of land transport*	1/3 *No audit*	1/3 *No corrective plan*	7.4

Each method had different levels of effectiveness regard the control oxide of nitrogen emission source at the plant studied. The most effectiveness of reducing the oxide of nitrogen emission is to control the temperature in the kiln. While, the least effective method involved getting the trucks certified by the Department of Land Transport.

B. Operating performance

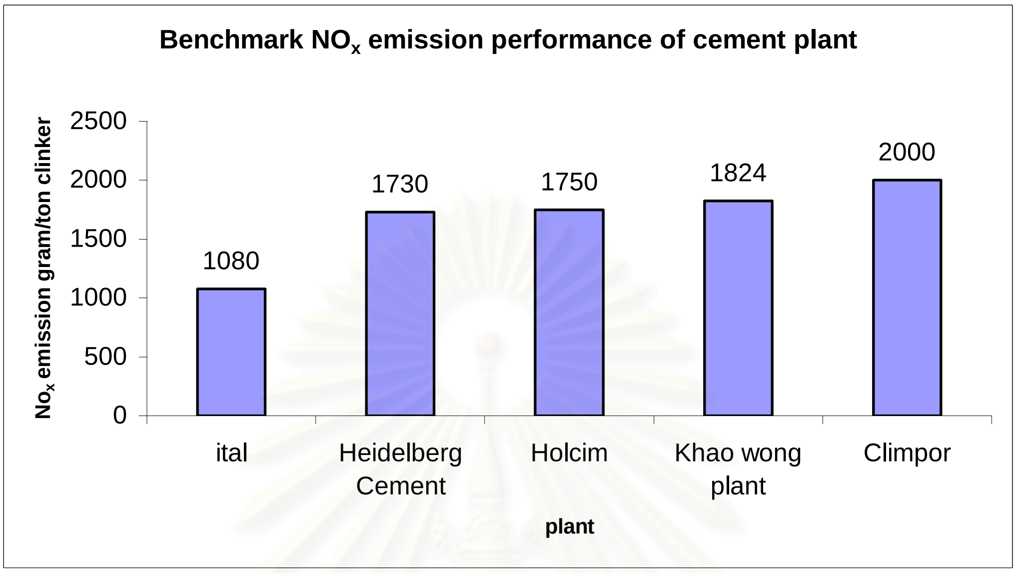
B.1 Direct impact

The indicator in this category is used to evaluate the quantity of oxide of nitrogen emission both absolute and specific emissions that is emited to the environment. It can be represented by the quantity of oxide of nitrogen from stack emissions and ambient air quality. Table 4.31 shows the oxide of nitrogen emission from stack both absolute and specific emission. The performance of dust in the workplace is concluded in Figure 4.11.

Table 4.31 *Absolute and specific oxide of nitrogen emission from the stacks of cement plant*

Significant aspect	Source	ton emission/year	g emission/ton production
NO_x	Process	6343.6	1824.0
	Traffic	25.9	7.4
	Total	6369.5	1831.4

Figure 4.11 *Comparison of oxide of nitrogen emission of the Khao Wong plant with other cement companies*



NO_x emissions are generate by fuel combustion at high temperatures and are a potential contributor to the formation of acid rain and smog. The others cement plant such as Ital, Heidelberg Cement invested heavily in low NO_x solutions through modernization of old kiln lines. The use of alternative fuel has also contributed to the reduction of NO_x emission.

Next direct impact indicator was quantity of oxide of nitrogen in ambient air quality, the indicators of ambient air quality were the percentage of compliance area and the average quality. Table 4.32 shows the percentage of community area pass the compliance oxide of nitrogen emission in ambient air quality and table 4.33 shows the average of air quality in this area. The performance of oxide of nitrogen in ambient air quality can conclude in the figure 4.12.

Table 4.32 *The degree of compliance of oxide of nitrogen emission (%) in ambient air*

Source	No. of Sample	No. of noncompliance	Degree of compliance (%)
Bahn Ngaung Pah Pong	168	0	100.0
Employee lodging	168	0	100.0
Bahn Kow Wong	168	0	100.0
Bahn Woong	168	0	100.0
Nah Pra Lahn school	168	0	100.0
Bahn Muang Fai	168	0	100.0

Table 4.33 *Average of oxide of nitrogen emission in ambient air*

Operation	Average NO_x emission in ambient (mg/m^3)	Standard average NO_x emission in ambient (mg/m^3)
Community of Khow Wong plant	0.01	≤0.17

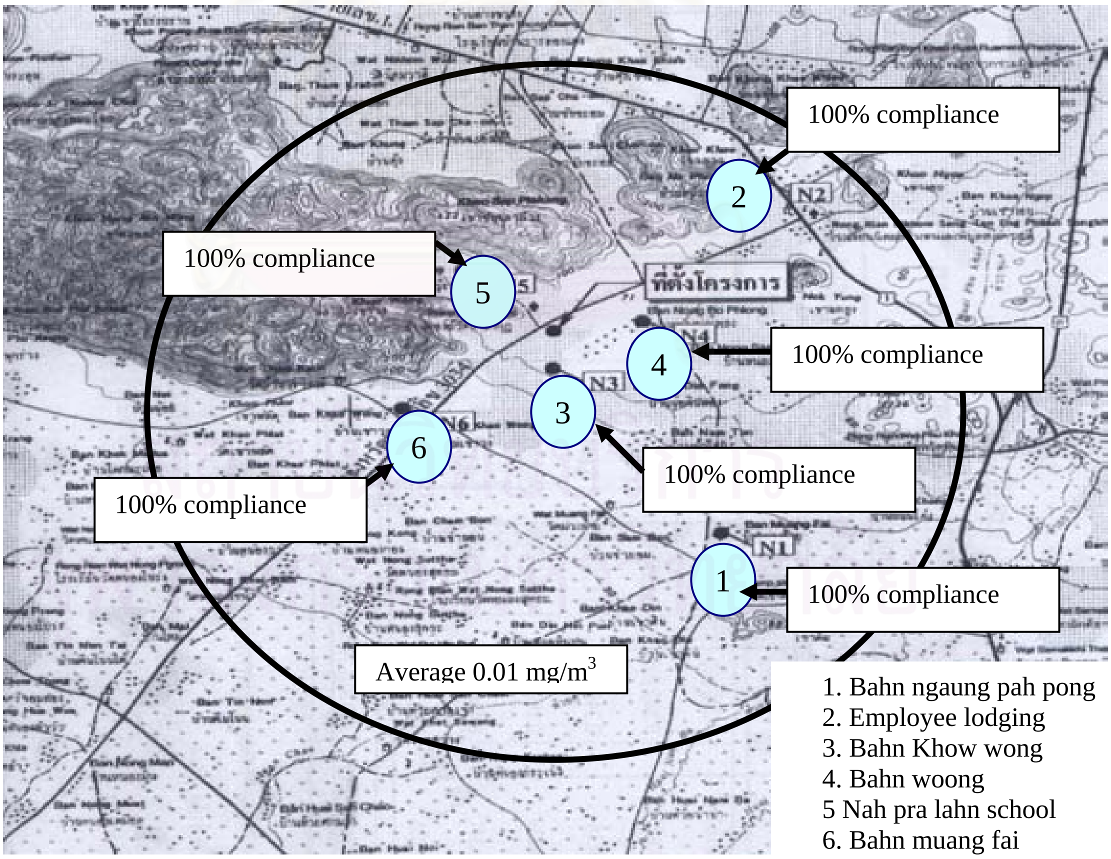


Figure 4.12 *The performance of oxide of nitrogen emission in ambient air*

Oxides of nitrogen (NO_X) are formed during clinker production at the high temperature (2000 °C) required to process the raw materials. This cement plant was reducing NO_X emissions by optimising the process continuously using the link-man system. From 2004, the specific NO_x was 1824 g/ton clinker. Performances of stack emissions met the standard of the PCD.

4.2.2.4 Environmental performance related to carbon dioxide emissions

Concern has been mounting the world over on the increasing emission of GHG's, such as CO_2 and methane owing to its implication in global climate. The cement industry's emission of CO_2 is next only to thermal power plants (coal based). Cement kilns burn coal and limestone, both of which generate CO_2. And then indirect emissions result from the use of electricity if fossil fuels are used for its generation. The approximate contributions of each of the CO_2 sources are calcination (50 to 55%), fuel combustion (40 to 50%), electricity (0 to 10%). Two areas of environmental performance evaluation were carried out as follows:

A. Management performance

A.1 Management inclusiveness

Indicator is represented by the percentage of carbon dioxide emission source controlled or managed to the total number of sources.

Table 4.34 *Carbon dioxide emission source and related control systems*

Significant aspect	Type	Source	Control
CO_2	Process	Calcination	No control
		Fuel combustion	Use alternative fuel (Biomass)
		Electricity	Improve process for decrease power consumption by link man system

The performance of management inclusiveness of carbon dioxide emission is 66.67% because this plant does not include CO_2 control during calcination. One possible alternative for CO2 reduction during calcinations is to decrease the limestone content in the clinker formulation.

A.2 Management effectiveness

The indicator of management effectiveness is the percentage of implementation effectiveness. The calculated effectiveness used criteria in Table 4.13, and Table 4.35 shows the effectiveness result of carbon dioxide control emission source.

Table 4.35 *Effectiveness of the carbon dioxide emission control at sources in the cement plant*

Source	Measure	Appropriateness	Coverage of practice	Audit system	Corrective action	% Effectiveness
Fuel combustion	Use alternative fuel (Biomass)	3/3 *Suitable method*	3/3 *All of the burner*	3/3 *KPI of cement plant*	3/3 *Active corrective plan*	100.0
Electricity	Improve process for decrease power consumption by link man system	3/3 *Advance technology*	2/3 *Used in machine of high energy*	3/3 *Preventive maintenance and daily check*	3/3 *Machine class A*	66.7

B. Operating performance

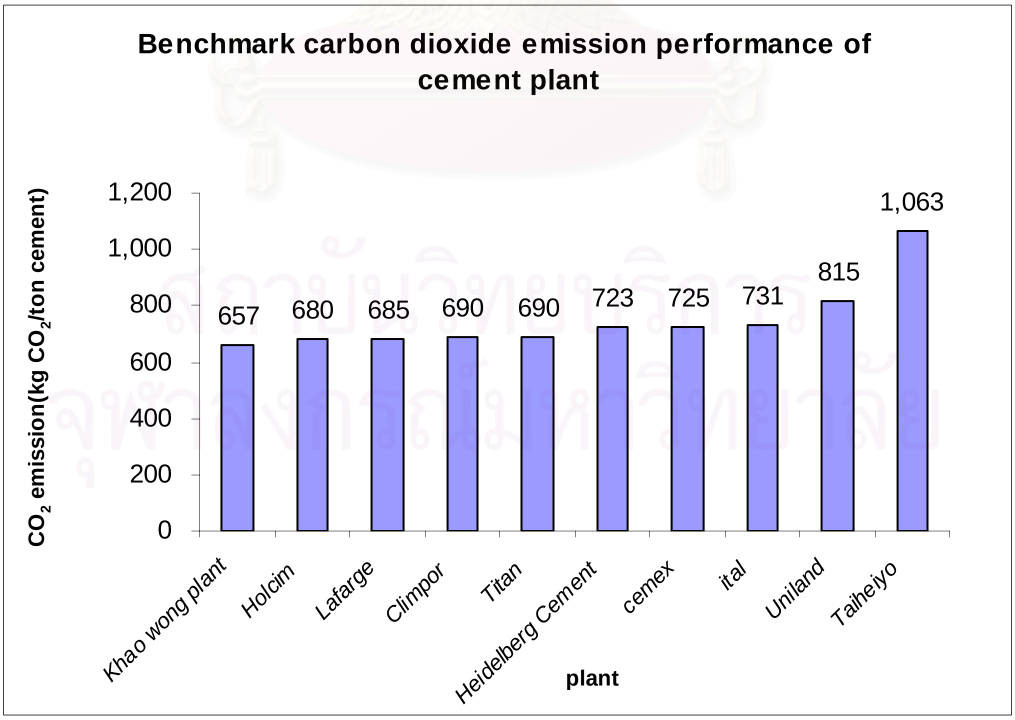
B.1 Direct impact

The indicator in this category is used to evaluate the quantity of carbon dioxide emission both absolute and specific emissions that are emited to the environment. Table 4.36 shows the carbon dioxide emission both absolute and specific emission and Figure 4.13 shows the carbon dioxide emission performance of the Khao Wong plant and the benchmark.

Table 4.36 *Absolute and specific carbon dioxide emission of the cement plant*

Significant aspect	Source	ton emission/year	kg emission/ton production
CO_2	Process	835,153	450
	Fuel	383,675	207
	Total	1,218,828	657

Figure 4.13 *Comparison of the carbon dioxide emission of the Khao Wong plant with other cement companies*



In terming of the environmental performance of the Siam Cement Industry's Ta-luang, Khao Wong factory, the amount of carbon dioxide is the best practice when compared with the others countries. Since the factory uses paddy husk and bark instead of coal, less CO_2 is generated and process for decrease power consumption is improved by the link-man system.

4.2.3 Reporting and communication

This performance is reported or communicated to interested parties within and outside the organization, based on the needs assessment of audiences. Stakeholders are divided into the following groups by specification of their needs in relation to the environmental information. There are two types of communication:

a) Internal reporting and communication

The environmental performances are reported to the management, employees and contractors to enhance their responsibility fulfillment.

b) External reporting and communication

An organization can chooses or is required to issue environmental reports or statements providing information describing its environmental performance to the external interested parties, such as the government, non-governmental organization, neighboring communities, shareholders and the customers. The environmental performance evaluation provides information that can be reported in the environmental report or by other communication means.

This section presents the suggestions concerning the communication of the EPE to some stakeholders of the cement plant studied.

- Management

The EPE information needs to be routinely communicated to management, up to and including the president of the organization. This will allow the management to adjust resources, arrange for changes to processes, or launch new programs. Communication of the EPE to management must be done briefly, accurately and routinely because the manager will be very active running the business.

From the organization of this cement plant, the environmental performance information was reported to each level of management, at different frequencies illustrated in Table 4.37

Table 4.37 *Information of the environmental performance report to each management level*

Management level	Duty of environmental control	Information	Frequency
Managing Board	Environmental policy and vision of The Siam Cement groups	All MPI and OPI	1 time/year in order to set environmental policy and vision of groups
Managing Director	Environmental policy and vision of Khao Wong factory	All MPI and OPI	2 times/year in order to set environmental policy and vision of this factory
Manager	Plan, target, goals, and KPIs	All MPI and OPI	Every month in order to evaluate the performance and set plan, target and goal following the policy and vision

Table 4.37 *Information of the environmental performance report to each management level (Cont.)*

Management level	Duty of environmental control	Information	Frequency
Supervisor	Plan practice and report to upper manager	Responsible MPI and OPI	Every month in order to estimate the performance and report to upper management

- Employees and contractors

The employees and contractors should also be given EPE information, especially, the performance related to their duties or responsible areas. This will help to get them more involved in environmental protection, which is necessary for long-term improvement. EPE communications to employee must be brief since most employees are busy with their other responsibilities. The message should also be clearly and accurately written.

Table 4.38 *The information of environmental report to employees*

Employee	Source	Content
Direct control emission	Blasting, loading, unloading, crushing, conveyor transfer, piling, road , electrostatic precipitator and bag filter	Emission performance that is generated at each source; workplace and ambient air quality; exposure level and complaints of emissions
Support control emission	Quality control , office, and cafeteria	workplace and ambient air quality, and complaints of emission

- General Publics

External communication can be done in many ways. For example, annual reports could include the EPE information. The neighbors and shareholders are starting to demand both negative and positive environmental results.

General information from the sustainable report was disclosed to the general public. The report concluded the following environmental information: environmental policies, plans, projects, assets/expenses, law conformity, and performance of emissions, such as OPI both absolute and specific emissions.

- Government

Some government agencies have required certain types of environmental performance information for years. Many permits also require that certain environmental performance data be submitted on a routine basis.

Table 4.39 *Environmental report information to the government*

Government agency	Content of routine report	Content of environmental report from industry
Department of Natural Resources and Environmental Policy and Planning	EIA measurement; Quantity of dust, SO_x, NO_X, dioxin from stack emission workplace air quality and ambient air quality	Management inclusiveness and effectiveness
Ministry of Industry	Quantity of dust, SO_x, NO_X, dioxin from stack emission workplace air quality and ambient air quality	Management inclusiveness and effectiveness
Provincial Industry offices and municipal authorities	EIA measurement; Quantity of dust, SO_x, NO_X, dioxin from stack emission workplace air quality and ambient air quality	Management inclusiveness and effectiveness and complaints of emission

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In this research, multi-stakeholder interest was incorporated into the environmental performance evaluation procedure using a cement factory as a case study. Two major steps of environmental performance evaluation: aspect identification and development of evaluation system were focused.

Stakeholder analysis was made in order to provide inputs for criteria setting in the identification and evaluation of significant aspects. In doing so, three groups of criteria were classified as level of stakeholders' concern, legislation, and environmental impact/ damage. It was found that, for cement industry, the emission of dust, SO_x, NO_x, and CO_2 came top of the list.

In the development of environmental performance evaluation system, the expectations from various stakeholders were analyzed and employed to extract related information. From this point, the environmental performance indicators were identified and categorized into groups. It was found that the set of indicators developed for cement industry fell into 2 basic performance indicators; management and operation, as stated in ISO 14001. The importance of stakeholder analysis was realized when the detailed management indicators were developed. Management inclusiveness and management effectiveness subcategories were proposed in response to the needs of most stakeholders for corporate's disclosure of its managerial initiation and actions. In this regards, the percentage of pollution sources identified and managed was selected to represent the management's concern while the effectiveness of environmental management measures was employed to describe the response of management by considering the appropriateness of action, the coverage of practice, the audit system implemented, and the corrective action.

For the operation side, the performance could be better understood through the consideration of impacts which were group into direct and indirect impacts. The indicators belong to direct impact category provided an insight information for the scale of environmental burdens put onto direct recipients which were neighborhood communities, and employees (including subcontractors' workers). These indicators were the quantity of pollutant released both in absolute and specific terms, workplace air quality, and ambient air quality. On the other hand, indirect impact category reflected the outcomes from the releases of pollutants such as personal exposure level, complaints, and penalty and fine.

In the end, the information related to all above indicators was collected at the plant studied to enabling the presentation of the environmental performances. It was expected that the performance evaluated herewith could be, in future, used as a platform for testing an appropriateness of the indicator set proposed and for benchmarking.

5.2 Recommendations for future study

In this environmental performance evaluation, this study could not complete the implement, check, and act steps. Therefore, the factory should review the environmental performance evaluation process. A review should be carried out in order to accomplish this improvement. Routine checks should be made against the original EPE plan to see if it needs to be changed or if it is performing according to design. It may be necessary to change the way data is collected, handled, and evaluated so that it is more reliable and useful. Certain environmental indicators may need to be changed, added, or dropped. The review will probably suggest changes that should be made to the management and operational systems. When these improvements are made, the state of the environment should automatically improve.

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APPENDICES

APPENDIX A

Calculation point source of dust emission performance

Performance of dust emission from stack has two situations. One is normal operation and another is abnormal operation such as electrostatic precipitators' trip.

A.1 Electrostatic precipitator case normal operation

Calculation of dust emission from normal operation is sampling data or direct measurement. Pollutant concentration is then multiplied by the volumetric flow rate to determine the emission rate in kilograms per hour, as shown in Equation 1.

Equation 1

$$E_{TSP,EP} = C_{TSP} * Qd * 31536$$

Where: $E_{TSP,EP}$ = hourly emissions of TSP, kg/hr

C_{TSP} = concentration of TSP or gram loading, g/m^3

Qd = stack gas volumetric flow rate, m^3/s, dry

31.536 = 31536 seconds per year multiplied by 0.001 kilograms per gram

Table A-1 *Example of calculation of electrostatic precipitator case normal operation*

Kiln	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.03	0.03	0.03	0.03	0.03	0.04	0.02	0.04	0.02	0.03	0.03	
Flow (Nm^3/s)	300.49	299.42	294.55	303.97	284.04	268.76	263.23	284.72	256.79	222.87	245.95	
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	
Emission(Ton/yr)	0.32	283.28	250.80	258.82	295.60	330.55	124.52	377.12	129.57	231.94	193.91	225.13

Cooler 1	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.01	0.02	0.02	0.06	0.02	0.02	0.03	0.07	0.02	0.05	0.02	
Flow (Nm^3/s)	96.92	93.85	94.50	99.36	108.19	106.25	103.79	103.60	100.93	94.53	101.50	
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	
Emission(Ton/yr)	21.40	68.07	59.60	178.60	51.18	73.72	88.37	238.50	63.66	137.13	76.82	96.10

Cooler 2	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.03	0.01	0.03	0.01	0.02	0.02	0.03	0.02	0.03	0.03	0.01	
Flow (Nm^3/s)	100.05	96.17	97.45	93.33	93.10	92.48	96.33	93.14	91.22	90.42	90.29	
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	
Emission(Ton/yr)	91.50	42.46	79.90	41.21	58.72	58.33	103.29	47.00	89.18	76.99	39.86	66.22

Table A-1 *Example of calculation of electrostatic precipitator case normal operation (Cont.)*

Cement Mill 1	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.01	0.02	0.12	0.06	0.05	0.02	0.03	0.04	0.04			
Flow (Nm^3/s)	9.83	9.16	10.82	10.20	10.33	10.43	10.37	10.15	9.20			
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54			
Emission(Ton/yr)	4.34	5.20	40.95	17.69	14.66	6.91	8.18	11.52	11.02			13.39

Cement Mill 2	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.01	0.01	0.01	0.01	0.03	0.01	0.03	0.02				
Flow (Nm^3/s)	10.21	9.85	8.69	8.79	10.89	10.40	10.83	10.22				
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54				
Emission(Ton/yr)	1.61	1.55	2.74	3.60	8.93	4.59	10.93	4.83				4.85

Cement Mill 3	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.04	0.01	0.01	0.07	0.04	0.03	0.05	0.02	0.04	0.02	0.03	
Flow (Nm^3/s)	8.32	8.30	8.62	8.24	10.09	9.94	10.65	10.79	10.56	10.70	10.79	
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	
Emission(Ton/yr)	9.18	3.40	3.53	18.45	11.14	8.46	15.45	7.15	11.66	6.07	11.57	9.64

Table A-1 *Example of calculation of electrostatic precipitator case normal operation (Cont.)*

Lignite Mill 1	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.02	0.01	0.01	0.02	0.03	0.06	0.02	0.03	0.05	0.02	0.02	
Flow (Nm^3/s)	21.92	20.43	20.65	22.52	15.59	16.84	19.71	22.11	15.14	15.37	16.73	
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	
Emission(Ton/yr)	12.44	7.09	8.47	16.33	15.24	29.21	13.67	20.92	22.92	10.66	7.91	14.99

Lignite Mill 2	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.04	0.02	0.01	0.01	0.04	0.05	0.07	0.04	0.03	0.03	0.02	
Flow (Nm^3/s)	11.83	12.22	14.80	13.83	17.66	22.11	23.48	22.64	22.71	23.02	23.10	
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	
Emission(Ton/yr)	16.04	6.94	4.20	4.36	22.83	33.47	50.35	28.56	19.34	18.15	12.38	19.69

Lignite Mill 3	no.1	no.2	no.3	no.4	no.5	no.6	no.7	no.8	no.9	no.10	no.11	Average
Concentration (g/Nm^3)	0.01	0.01	0.01	0.02	0.02	0.02	0.04	0.04				
Flow (Nm^3/s)	13.41	13.62	13.19	14.54	13.60	19.94	19.77	15.87				
constant	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54				
Emission(Ton/yr)	4.65	3.44	4.16	6.88	9.86	11.32	22.44	20.02				10.35
Total Emission (ton/year)												460.35

A.2 Electrostatic precipitator case abnormal operation

Electrostatic precipitators' trip cans calculation dust emission by total time of electrostatic precipitators' trip multiple by emission factor of release emission as shown in Equation 2.

Equation 2

$$E_{TSP,EPAb} = EF_{TSP,EPAb} * A * OpHrs * 10^{-6}$$

where:

$E_{TSP,EPAb}$ = annual emissions of TSP, kg/yr

$EF_{TSP,EPAb}$ = emission factor for TSP, mg/m3, in this case 80mg/m^3

A = activity rate (hourly flow of air exhausted through the electrostatic precipitators' trip), m^3/hr (990000 m^3/hr)

OpHrs = hours of electrostatic precipitators' trip, hr/yr

10^{-6} = conversion factor mg to kg.

(Where 80 mg/m^3 is capacity total particulate matter emission with out through electrostatic precipitators)

Table A-2 *Example of calculation of electrostatic precipitator case abnormal operation*

Month	EF_{TSP}	A	OpHrs	kg	E_{TSP}
January	80	990000	42	1000000.00	3.3264
February	80	990000		1000000.00	0
March	80	990000	27	1000000.00	2.1384
April	80	990000		1000000.00	0
May	80	990000	15	1000000.00	1.188
June	80	990000	77	1000000.00	6.0984
July	80	990000	23	1000000.00	1.8216
August	80	990000	39	1000000.00	3.0888
September	80	990000	43	1000000.00	3.4056
October	80	990000	93	1000000.00	7.3656
November	80	990000	8	1000000.00	0.6336
December	80	990000	49	1000000.00	3.8808
total					32.9472

A.3 Bag filters case normal operation

Bag filters venting outside: Equation 3 can be used to calculate annual emissions of dust when using outside-venting bag filters.

Equation 3

$$E_{TSP,\,BF} = EF_{TSP} * A * OpHrs * 10^{-6}$$

where:

$E_{TSP,BF}$ = annual emissions of TSP, kg/yr

EF_{TSP} = emission factor for TSP, mg/m3, in this case 12mg/m^3

A = activity rate (hourly flow of air exhausted through the bag filter), m^3/hr (108 m^3/hr)

OpHrs = operating hours, hr/yr

10^{-6} = conversion factor mg to kg.

(Where 12mg/m^3 is capacity of bag filter 80% of the total particulate matter)

Table A-3 *Example of calculation of bag filter case normal operation*

Issue	Time of operation (hr)	Quantity of TSP from bag filter (ton/year).
Average 1 bag filter	7008	2.0
Total 131 bag filter		262

APPENDIX B

แบบสอบถามประกอบเวทีชาวบ้าน

โครงการชุมชนสีเขียวเขาวงน่าอยู่อย่างยั่งยืน

ชื่อ – นามสกุลผู้ตอบ

แบบสอบถาม…………………………………………………………………………………

ที่อยู่ปัจจุบันบ้านเลขที่………………..หมู่ที่………. ตำบลเขาวง อำเภอพระพุทธบาท จังหวัดสระบุรี

วันที่ตอบแบบสอบถาม……………เดือน………………………… พ.ศ. 2547

คำอธิบาย : กรุณาทำเครื่องหมาย / ลงในคำตอบที่ท่านเลือกตอบใน ( ) และเติมคำลงในช่องว่าง……….ที่ตรงกับความเป็นจริงหรือตรงกับความคิดของท่าน

<u>ส่วนที่ 1</u> ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม

1. เพศ ( )ชาย ( )หญิง
2. ปัจจุบันอายุ…………..ปี
3. ระดับการศึกษาสูงสุด

   ( )ไม่ได้ศึกษา ( )ประถมศึกษา ( )มัธยมศึกษา ( )ปวช.

   ( )ปวส. ( )อนุปริญญา ( )ปริญญาตรี ( )อื่นๆ

   (ระบุ)…………...
4. อยู่อาศัยในหมู่บ้านมาเป็นเวลา…………..ปี
5. อนาคตคิดว่าจะย้ายไปอยู่อาศัยที่อื่นหรือไม่ เพราะเหตุใด

   ( )ไม่ย้าย เพราะ

   ……………………………………………………………………………………..

   ( )ย้ายไปอยู่ที่จังหวัด……………………….. เพราะ

   ……………………………………………………………………………………..

   ( )ยังไม่แน่
6. สถานภาพภายในครอบครัว

   ( )หัวหน้าครอบครัว ( )ผู้อยู่อาศัย

7. จำนวนสมาชิกที่อยู่อาศัยร่วมกันภายในบ้าน……….คน
8. อาชีพหลักของผู้ตอบแบบสอบถาม(อาชีพที่ได้รายได้สูงสุด)

( )ไม่ได้ทำงาน

( )รับราชการ หรือ รัฐวิสาหกิจ สถานที่ทำงาน...

( )พนักงานหรือคนงานบริษัทปูนซิเมนต์ไทยเป็นระยะเวลา……………..ปี

สถานที่ทำงาน..

( )พนักงานหรือคนงานบริษัทเอกชนอื่นๆ

สถานที่ทำงาน..

( )ค้าขาย

สถานที่ทำงาน..

( )ทำสวนการเกษตร

สถานที่ทำงาน..

( )รับจ้างทั่วไป

สถานที่ทำงาน..

( )อื่นๆ(ระบุ)………………………………….

สถานที่ทำงาน..

9. อาชีพรองของผู้ตอบแบบสอบถาม(อาชีพที่เป็นรายได้เสริม)

( )ไม่มี

( )ค้าขาย

( )ทำสวนการเกษตร

( )รับจ้างทั่วไป

( )อื่นๆ(ระบุ)………………………………….

10. รายได้เฉลี่ยต่อเดือนของผู้ตอบแบบสอบถามเป็นเงิน…………………….บาท
11. รายจ่ายเฉลี่ยต่อเดือนของผู้ตอบแบบสอบถามเป็นเงิน…………………….บาท
12. รายได้เฉลี่ยต่อเดือนภายในครอบครัวของผู้ตอบแบบสอบถามเป็นเงิน…………………….บาท
13. รายจ่ายเฉลี่ยต่อเดือนภายในครอบครัวของผู้ตอบแบบสอบถามเป็นเงิน…………………….
บาท ได้แก่

13.1. รายจ่ายในครัวเรือนต่อเดือน…………………….บาท

13.2. รายจ่ายหนี้สินต่อเดือน……………………บาท

13.3. รายจ่ายอื่นๆเฉลี่ยต่อเดือน…………………..บาท

ส่วนที่ 2 ข้อมูลเกี่ยวกับสภาพปัญหา และความคิดในการแก้ไขปัญหา

1. ท่านมีปัญหาภายในครอบครัวอะไรบ้าง และคิดว่าจะมีวิธีแก้ไขปัญหาเหล่านี้อย่างไร

 1.1. ปัญหา…………………………………………………………………………………

 ……………………………………………………………………………………………...

 วิธีแก้ไขปัญหา……………………………………………………………………...

 1.2. ปัญหา…………………………………………………………………………………

 ……………………………………………………………………………………………...

 วิธีแก้ไขปัญหา……………………………………………………………………….

 1.3. ปัญหา…………………………………………………………………………………

 …………...

 วิธีแก้ไขปัญหา…………………………………………………………………......….

2. ภายในหมู่บ้านของท่านมีปัญหาอะไรบ้าง และถ้าท่านสามารถแก้ไขปัญหาเหล่านั้นได้ท่านจะทำอย่างไร

 2.1. ปัญหา…………………………………………………………………………………

 วิธีแก้ไขปัญหา……………………………………………………………......…….

 2.2. ปัญหา…………………………………………………………………………………….

 วิธีแก้ไขปัญหา…………………………………………………………………...….

 2.3. ปัญหา…………………………………………………………………………………….

 วิธีแก้ไขปัญหา……………………………………………………………………….

3. ท่านมีความฝันว่าอยากให้หมู่บ้านท่านเป็นอย่างไร

 3.1. ……………………………………………………………………………………..

 3.2. ……………………………………………………………………………………..

 3.3. ……………………………………………………………………………………..

4. ท่านอยากให้หมู่บ้านได้รับการพัฒนาอะไรบ้าง และคิดว่าจะพัฒนาอย่างไร

 4.1. พัฒนา……………………………………………………………………………...

 วิธีพัฒนา…….……………………………………………………………..……….

 4.2. พัฒนา……………………………………………………………………………...

 วิธีพัฒนา…….……………………………………………………………..……….

 4.3. พัฒนา……………………………………………………………………………...

 วิธีพัฒนา…….……………………………………………………………..……….

คณะทำงาน “ทีมชุมชนสีเขียว”

APPENDIX C

แบบสอบถามโครงการประเมินประสิทธิผลด้านสิ่งแวดล้อม

ในด้านความสนใจของพนักงานต่อผลกระทบกับสิ่งแวดล้อม

บริษัทปูนซิเมนต์ไทย ท่าหลวงจำกัด โรงงานเขาวง อ.พระพุทธบาท จ.สระบุรี

1. รายละเอียดผู้ให้สัมภาษณ์

( ) พนักงานประจำแผนก..................................

( ) พนักงานชั่วคราวแผนก................................

2. ความสนใจของพนักงานต่อการปล่อยมลพิษสู่สิ่งแวดล้อมจากการทำงานของโรงงาน โปรดแสดงเครื่องหมายถูกหน้าหัวข้อที่สนใจ พร้อมเหตุผลที่สนใจ

ประเด็นหลัก	ประเด็นรอง	เหตุผลที่สนใจ
มลพิษทางอากาศ	( ) ฝุ่นละออง	
	( ) ก๊าซซัลเฟอร์ไดออกไซด์	
	( ) ก๊าซออกไซด์ของไนโตรเจน	
	( ) ก๊าซคาร์บอนไดออกไซด์	
	( ) ก๊าซคาร์บอนมอนอกไซด์	
	( ) ไอระเหยจาก liquid waste	
	( ) ก๊าซไดออกซิน	
สภาพแวดล้อมการทำงาน	( ) มลภาวะทางเสียง	
	( ) ความร้อน	
	( ) การสั่นสะเทือน	

3. ความสนใจของพนักงานต่อการใช้ทรัพยากรธรรมชาติจากการทำงานของโรงงาน

โปรดแสดงเครื่องหมายถูกหน้าหัวข้อที่สนใจ พร้อมเหตุผลที่สนใจ

ประเด็นหลัก	ประเด็นรอง	เหตุผลที่สนใจ
ทรัพยากรน้ำ	( ) น้ำผิวดิน	
	( ) น้ำใต้ดิน	
เชื้อเพลิง	( ) ไฟฟ้า	
	( ) ถ่านหิน	
	( ) เชื้อเพลิงทดแทน เช่น แกลบ	
	( ) เชื้อเพลิงทดแทนที่เป็นของเหลว	
ทรัพยากรธรรมชาติ	( ) หินปูน	
	( ) ดินดาล	
	( ) ดินดำ	
	( ) ดินลูกรัง	
	( ) ยิปซั่ม	

BIOGRAPHY

Miss Laksanawan Polompai was born on July 2, 1976 at Bangkok-noi district, Bangkok and graduated from high school at Benjamaracharai School in 1994. She has been graduated the bachelor degree of General Science from Chulalongkorn University in 1999. After graduation, she worked at MV Food supply until 2003. She entered the Master of Science in Environmental Management Program at Chulalongkorn University in 2003.