

## THESIS APPROVAL

### GRADUATE SCHOOL, KASETSART UNIVERSITY

Master of Engineering (Environmental Engineering)

DEGREE

Environmental Engineering

FIELD

Environmental Engineering

DEPARTMENT

**TITLE:** Efficiently Enhanced Environmental Management System (ISO14001) by  
Pollution Prevention in Thailand

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THESIS

EFFICIENTLY ENHANCED ENVIRONMENTAL MANAGEMENT  
SYSTEM (ISO14001) BY POLLUTION PREVENTION IN  
THAILAND

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A Thesis Submitted in Partial Fulfillment of  
the Requirements for the Degree of  
Master of Engineering (Environmental Engineering)  
Graduate School, Kasetsart University  
2009

Phanthipa Sawatee 2009: Efficiently Enhanced Environmental Management System (ISO14001) by Pollution Prevention in Thailand. Master of Engineering (Environmental Engineering), Major Field: Environmental Engineering, Department of Environmental Engineering. Thesis Advisor: Assistant Professor Cheema Soralum, Ph.D. 120 pages.

The purpose of this study was to investigate the relationship of implementing pollution prevention (P2) and ISO14001 in organizations that have been receiving the ISO14001 certification in Thailand and also how P2 affects the environmental management system (EMS). The research was conducted by questionnaires and semi-interviews, among 315 questionnaire sent 46% returned and 3 enterprises with different business background were interviewed. Results showed that the returned questionnaire were from 70.3%, 24.8% and 4.8% of large, medium and small organization respectively. All of them 94.4% have been continuously implementing ISO14001. Results also found that 25% of the organizations agree that P2 tools such as 3Rs can be conducted well with environmental management system. To study the efficiency of the organization's environmental performance, questions related to ISO14031 (Environmental Performance Evaluation) were asked in the content of management and operation performance indicators (MPI and OPI) and environmental condition indicators (ECI). The result was statistically analyzed by comparing means with one-sample t test at 95% confidence interval was reported P value = 0.000 (1-tailed),  $\alpha = 0.005$ . It was found that P2 operated together with ISO14001 could efficiently enhanced ISO14001.

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Student's signature

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Thesis Advisor's signature

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## ACKNOWLEDGEMENTS

I would like to grateful thank and deeply indebted to my thesis advisor, Assistant Professor Dr.Cheema Soralump for valuable advice throughout completely writing of thesis as well as Assistant Professor Dr.Sanya Sirivithayapakorn for valuable comments and suggestion.

I would like to sincerely thank for all enterprises in Thailand which kindly cooperation to answer questionnaire, interviews, moreover I would like to deeply thank you Ms.Darunee Khangkhaket, audit division manager, system certification department from Management System Certification Institute (Thailand) for valuable comment.

In addition, I would like to sincerely thank you all teachers which give knowledge for develop my skill to use available know-how and I would like to thank you all officers which good support throughout do thesis.

Finally, I would like to special thanks for my family for their good continuing encouragements.

Phanthipa Sawatee

October 2009

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## LIST OF ABBREVIATIONS

3R	=	Reuse, reduce and recycle
5S	=	The name of a workplace organization methodology that uses a list of 5 Japanese words which seiri (sorting), seiton (straighten), seiso (sweeping), seiketsu (standardizing), shisuke (sustaining the discipline)
Aft_QO	=	After question of operation
Bef_QO	=	Before question of operation
CP	=	Cleaner Production
CT	=	Cleaner Technology
df	=	Degree of freedom
DFE	=	Design-for-the environment
EA	=	Environmental Aspects
ECI	=	Environmental Condition Indicator
Eco design	=	Economic & Ecological design
EIA	=	Environmental Impact Assessment
EMS	=	Environmental Management System
EP	=	Environmental Performance
EPE	=	Environmental Performance Evaluation
$H_0$	=	Null Hypothesis
$H_1$	=	Alternative Hypothesis
ISO	=	the International Organization for Standardization
ISO14001:2004	=	Environmental management systems-Requirements with guidance for use
ISO14031	=	Environmental management-Environmental performance evaluation-Guidelines
KPI	=	Key performance Indicator
LCA	=	Life cycle assessment
LCD	=	Life-cycle design
MPI	=	Management Performance Indicator
N	=	A number of sampling

## LIST OF ABBREVIATIONS (Continued)

NO <sub>x</sub>	=	Oxides of Nitrogen
OPI	=	Operation Performance Indicator
P	=	Question which concerns P2
P value	=	Probability value
P2	=	Pollution Prevention
QE	=	Environment Question
QG	=	General Question
QM	=	Management Performance Indicator Question
QO	=	Operation Performance Indicator Question
RoHs	=	Restriction of Hazardous Substances
SEPE-index	=	The state of environmental performance evaluation-index
Sig.	=	Significance
SMEs	=	Small and Medium Enterprises
SPD	=	Sustainable product design
SPSS	=	Statistical Package for the Social Sciences
Std. Deviation	=	Standard Deviation
Std. Error Mean	=	Standard Error Mean
THB	=	Thai baht
TPM	=	Total Productive Maintenance
VOCs	=	Volatile Organic Compounds
WEEE	=	Waste Electrical and Electronic Equipment
$\alpha$	=	Level of significance

# **EFFICIENTLY ENHANCED ENVIRONMENTAL MANAGEMENT SYSTEM (ISO14001) BY POLLUTION PREVENTION IN THAILAND**

## **INTRODUCTION**

Nowadays environmental management system in Thailand is pushed to using in small enterprises through large enterprises in namely ISO14001:2004 by Department of Industrial Works. The similar important point of all enterprises are use system for commercial but some enterprise strictly to use the system because of they focused on benefits that they should get by reduce cost, materials, energy and wastes furthermore its enhance productions. Otherwise they consider to raw materials that might be impact to consumers and pollute to environment.

For this reason to save cost and reduce pollution, some enterprise considers on available of the system so they take others technique for support environmental management such as Pollution Prevention (P2) / Cleaner Technology (CT) which is a technique will be effective and efficient enhancing of environmental management system. In the other hand Department of Industrial Works is pushed the pollution prevention technique to SME enterprises for environmental management by reduce raw materials, energy and wastes as same as ISO14001:2004 therefore both systems can push together to raise effective and efficient system and sustainable continual development.

## **OBJECTIVES**

1. To study the relation between ISO14001 and pollution prevention how they reduce environmental burdens.
2. To study how pollution prevention can efficiently enhance environmental Management system.
3. To study trends to use pollution prevention technique to efficiently enhance environmental management (ISO14001) in enterprises in Thailand.

# LITERATURE REVIEW

## 1. ISO14001

Environmental Management Systems (EMSs) are tools for managing the interaction between the organization and environment (Perotto *et al.*, 2007).

The ISO14000 series (The Lexington Group, 2008) comprise of

ISO14001: Environmental Management System (EMS). The formal elements of an environmental management system include environmental policy, planning, implementation, verification and management review.

ISO14004: General Guidance for developing and implementing an EMS.

ISO14010-12: Environmental auditing principles and guidance.

ISO14031: Environmental performance evaluation guidance.

ISO14020-24: Environmental labeling guidance (Products)

ISO14040-45: Life-cycle Assessment principles and guidance (mainly products)

ISO14050: Terms and definitions

ISO Guide64: Inclusion of environmental aspects in product standards (Guide).

In this study we focused on ISO14001 because of the system is emphasized environmental management and reduce environmental burdens by set environmental policy, objectives and do activities so the system will gets successful from intention of all staffs, especially this system must gets supporting and take care of activities by top management.

Definition of Environmental Management System (EMS), ISO14001, is a voluntary international standard that specifies a process for controlling and improving a company's environmental performance, the system used to develop and implement its environmental policy and manage its environmental aspects. (ISO14001

Environmental management systems-Requirements with guidance for use. ISO14001:2004(E)., Filtration Industry Analyst, 2005., <http://www.iso.org>., <http://www.tisi.go.th>).

Most EMS is built on the Plan, Do, Check, Act model. So, EMS is a continual cycle of planning, implementing, reviewing and improving the processes and actions, an example of EMS process approach to continual improvement can explain as following table 1.

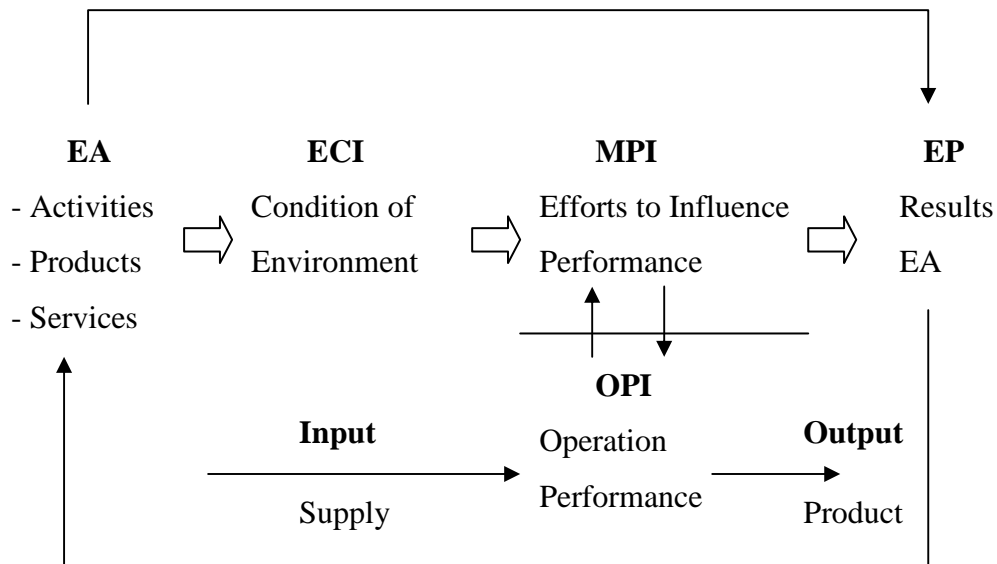
**Table 1** Environmental Management System (EMS) process approach

Process	Details
Environmental Policy	Overall intentions and direction of an organization related to its environmental performance as formally expressed by top management.
Planning	Establish the objectives and processes necessary to deliver results in accordance with the organization's environmental policy.
Implementation and operation	Implement the processes.
Checking	Monitor and measure processes against environmental policy, objectives, targets, legal and other requirements and report the results.
Management review	Take actions to continually improve performance of the Environmental Management System

**Source:** Perotto *et al.* (2007.)

In order to evaluate efficiently of EMS, an organization should assess its environmental performance against its environmental policy, objectives, targets, environmental aspects and performance criteria.

The aim of EMS is to improve the overall environmental performance of the organization. The ISO14001:2004 standard defines the environmental performance as measurable results of an organization's management of its environmental aspects. To help the organizations in the process of performance measurement, International Standard Organization (ISO) has developed the specific standard ISO14031 (Environmental Performance Evaluation, EPE) to be indicators to make measurement of the environmental performance, this indicators is defined to "specific expression that provide information about an organization's environmental performance" and their scope is to make measurement of the environmental performance easier for organizations.



**Figure 1** Relation of ISO14001 and EPE.

**Remark** Abbreviations as above are mean:

- EA = Environmental Aspects
- ECI = Environmental Condition Indicator
- MPI = Management Performance Indicator
- OPI = Operation Performance Indicator
- EP = Environmental Performance

**Source:** Thai Environmental Engineering Journal (1999.)

According to ISO14031, EPE is divided as follows

#### 1. Environmental Performance Indicator (EPI)

Specific expression that provides information about an organization's environmental performance, which are divided into:

- Management Performance Indicators (MPI) that provide information about the management efforts to influence an organization's environmental performance.
- Operational Performance Indicators (OPI) that provides information about the environmental performance of an organization's operations.

#### 2. Environmental Condition Indicators (ECI)

Specific expression that provides information about the local, regional, national or global conditions of the environment.

The ECI provide information about the condition 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 in the planning and implementation of EMS.

From indicators as above, provided an example for define the corresponding indicators which linking activities of products or services and their environmental aspects as following table2. (Perotto et al., 2007).

**Table 2** Example of a table for linking activities and their environmental aspects

Activity/ product/ service	Environmental aspect	Condition	Indicators		
			OPI	MPI	ECI
Combustion	Emission into atmosphere	N, A, E	Emission NO <sub>x</sub> / unit product	No. of calls for maintenance per year	NO <sub>x</sub> concentration in air

**Remark** N = normal operating conditions.

A = abnormal conditions.

E = emergency situations and accidents.

According to the standard EPE is “a process to facilitate management decision regarding an organization’s environmental performance by selecting indicators, collecting and analysis data, assessing information against environmental performance criteria, reporting and communicating, and periodically reviewing and improving this process. For evaluate state of EPE can use questionnaire and analyze them as follow as issues by the state of environmental performance evaluation (SEPE)-index (Ramos et al., 2009) which computed following equation:

$$SEPE = \sum_{j=1}^m \left( \frac{\sum_{i=1}^n X_i}{n} \right)_j$$

Where  $X_i$  = the environmental performance of the variable  $i$

$n$  = total number of  $i$  variables

$m$  = total number of questionnaire/ population

Furthermore EPE can apply Spearman's correlation non parametric test was performed to assess the relationship between unit size and the SEPE index.

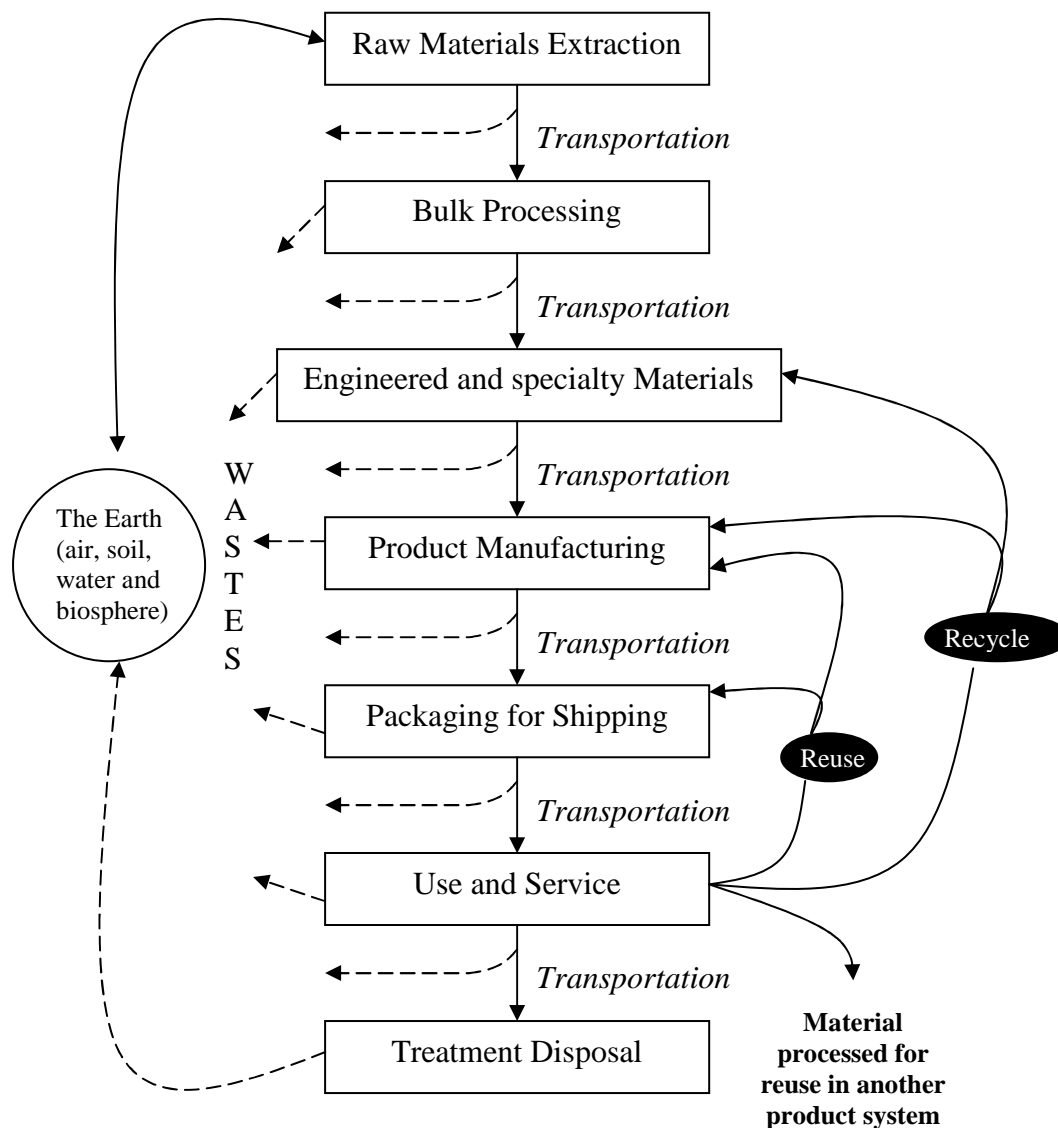
## **2. Pollution Prevention (P2)/ Cleaner Technology (CT)**

The Pollution Prevention 1997: A National Progress Report identifies pollution prevention initiatives as potentially the most effective for reducing risks to human health and the environment, as well as the most cost-effective method of environmental protection (Ligia Roviralta Moss, 2007). It being to use in industry for support environmental policy of the ISO14001. The analyses were performed with the objective of assessing general aspects of ISO14001 to upgrade their environmental performance. It emphasizes a preventive approach to environmental management taking into account impacts over the whole life cycle of products and services. Pollution Prevention is achieved by upgrading technology, process changes and process modifications, substitution of input materials, good operating practices (good house keeping), on-site reuse and recycling or product redesign. So the essential characteristic of the P2 approach is the "reduction at source" principle, derived from the idea that the generation of pollutants can be reduced or eliminated by increasing efficiency in the use of raw materials, energy, water and other resources.

### **2.1 Design-for-the-environment (DFE)**

From the principle of "reduction at source" can use design-for-the-environment (DFE) to reduce the overall environmental impact of products and services through use of a life cycle perspective.

DFE has many synonyms depending on where it is used. It can also be described as ecodesign (primary used in Europe) or life-cycle design (LCD). Adding social and economic issues expands DFE to the term sustainable product design (SPD) or design for sustainability. So LCA is one alternative tool which use DFE program for assessment as figure2 shows a typical life-cycle of a product and where various life-cycle stages potentially affect the environment. (Kurk and Eagan, 2007).



**Figure 2** A typical life-cycle representation

## 2.2 Types of DFE tools

The most fundamental tool use for guiding and analyzing a product's design feature is a check list of Yes/ No questions. The series of questions encompass the entire life-cycle of the product which describe as table 3. (Kurk and Eagan, 2007).

**Table 3** Example of partial checklist tool for life cycle stage

<b>Item</b>	<b>Related Questionnaire</b>
<b>I. Materials selection</b>	<ul style="list-style-type: none"> <li>- Are there plant or biobased materials or by-products from other processes that can be used as raw materials for this product?</li> <li>- Are the number and types of materials used in the product minimized?</li> </ul>
<b>II. Manufacture</b>	<ul style="list-style-type: none"> <li>- Is the product designed to avoid the need for using hazardous or restricted materials during the manufacturing process?</li> <li>- Does the design minimize waste during the manufacturing process including surplus coating, cut-always, trimmings, by-products?</li> </ul>
<b>III. Use</b>	<ul style="list-style-type: none"> <li>- Does the product design allow ease of disassembly for repair, upgrade or reuse?</li> <li>- Is alternative or efficient use of power designed into the product?</li> </ul>
<b>IV. Transport &amp; Packaging</b>	<ul style="list-style-type: none"> <li>- Are restricted or hazardous materials avoided in the inks, pigments, and materials used to package the product?</li> <li>- Will the design allow for use of reusable transport packaging?</li> </ul>
<b>V. End of life</b>	<ul style="list-style-type: none"> <li>- Does the design allow for ease of disassembly for reuse, recycling or composting?</li> <li>- Are the materials designated in the design labeled, easy to identify by type, and easy to separate?</li> </ul>

The resulting score would be used for internal comparison purpose only. A design revision can be evaluated against the original design.

### 2.3 Step of P2 performance

Success of P2 must get commitment from the top management and true implementation of P2 techniques results in cost effective environmental management and brings the business close to ISO certification. So step to make P2 program for build a confident which gets more advantages to top management are described in Khan, 2006 as following below.

Step-1: Top management selects an engineer or manager from middle management that is relatively well versed with the concept of P2 and calls him the P2 champion.

Step-2: The P2 champion will put together a P2 team comprised of supervisors from each section and the most experienced and active for staff.

Step-3: The P2 team will review past and present environmental and economic activities and contracts of the organization and identify opportunities where improvements can enhance environmental compliance, economic benefits or social stature of the organization. Smart P2 teams revisit organization's "vision for the future" and incorporate future plans e.g. ISO certification and initiate necessary documentation of the collected data at the same time. Most common areas of P2 opportunities include: raw materials, water management, wastewater management, energy consumption, maintenance, technology being used with reference to the best available technology, consumables, packaging etc.

Step-4: From the list of P2 opportunities prepared in step-3, P2 team will focus on the few most promising ones and explore to what extent changes would help reducing costs or improving environmental performance of the organization.

Step-5: After extensive exploration of opportunities, P2 plans are prepared for implementation of the changes recommended by the P2 team. Achievable goals and milestones are set and concerted efforts are done to achieve the goals.

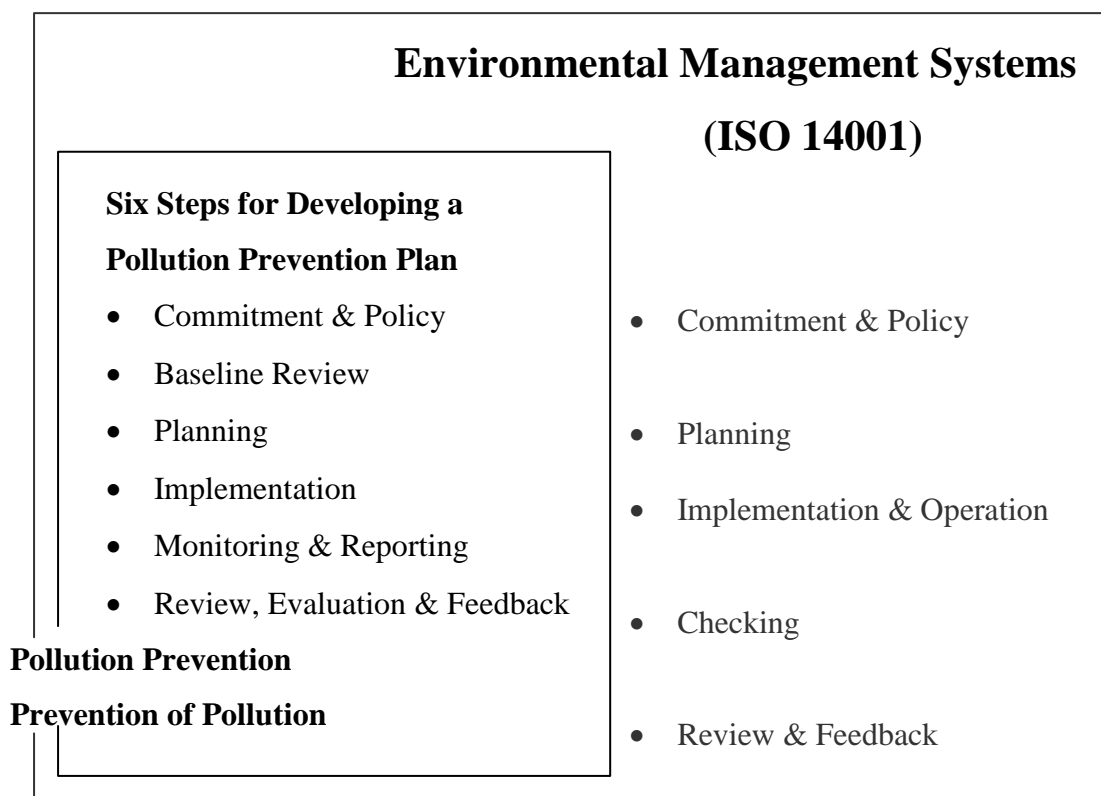
Step-6: Monthly or bimonthly meetings of the P2 team keep track of improvements and barriers in implementation of P2 plans.

Step-7: Steps 4, 5 and 6 are repeated until most of the P2 opportunities are extensively explored and changes implemented.

For P2 evaluation and measurement should compare differentiate of both before and after operational results, the P2 benefits will be save cost such as reduced operating costs, reduced regulatory burdens and reduced future liabilities.

### **3. Comparing EMS and P2 Programs**

Environmental Management Systems has 5 steps to approach for successfully to continual improvement but P2 has 6 steps to approach to developing a pollution prevention, so when compare EMS with P2 that found some steps is similar as below.



**Figure 3** Comparing step of EMS and P2 technique

**Source:** CEPA Pollution Prevention Planning Handbook (2003.)

EMS and P2 have similar step and performance purpose to reduce environmental impact so P2 should be technique to support and push EMS fast gets achievement.

#### **4. Environmental management situation in Thailand**

For P2 and EMS reference in Thailand , They can be found at Thai Industrial Standards Institute, TISI, Ministry of Industry (<http://www.tisi.go.th>), Thai Industrial standards Institute Library., Thailand Environment Institute, TEI, (<http://www.tei.or.th>), Ministry of Natural Resource and Environment, PCD, (<http://www.pcd.go.th>), Cleaner Technology unit, Department of Industrial works, DIW, <http://php.diw.go.th/ctu/>, The Federation of Thai Industries, FTI,

(<http://www.fti.or.th>), e-report energy (<http://www.oepp.go.th>), Department of Environmental Quality Promotion, DEQP, Ministry of Natural Resources and Environment (<http://www.depq.go.th>), Thai plastics Foam Recycling Industries Association, TPFRIA, (<http://www.tpfria.or.th>), Ministry of Energy (<http://www.energy.go.th>), Ministry of science and Technology (<http://www.most.go.th>), Industrial Estate Authority of Thailand, IEAT, (<http://www.ieat.go.th>), Monitoring net (<http://monitor.onep.go.th>), EnvironNet (<http://www.environnet.in.th>), The Environmental Engineering Association of Thailand, EEAT, (<http://www.eeat.or.th>), Environmental Research and Training Center, ERTC, (<http://www.ertc.depq.go.th>), National Metal and Materials Technology Center, MTEC, National Science and Technology Development Agency, Ministry of Science and Technology (<http://www.mtec.or.th>).

## MATERIALS AND METHOD

### Materials

1. Note book computer	1	set
2. SPSS software	1	set
3. A questionnaire	315	sets

#### Remark:

- Calculated amount of a questionnaire by Taro Yamane Technique.
- Reference data from a number of ISO14001 which registered with Department of Industrial Work on 13<sup>th</sup> June 2008 had 1,487 enterprises got ISO14001 certification.

### Methods

#### 1. Sampling selection

According to on 13<sup>th</sup> June 2008, Thailand have 1,487 companies has been taken ISO14001 certification, so should sampling selection for send questionnaire by Taro Yamane Technique

$$n = \frac{N}{1 + N(e^2)}$$

Where n = sampling size

N = population size

E = error estimation at 0.05

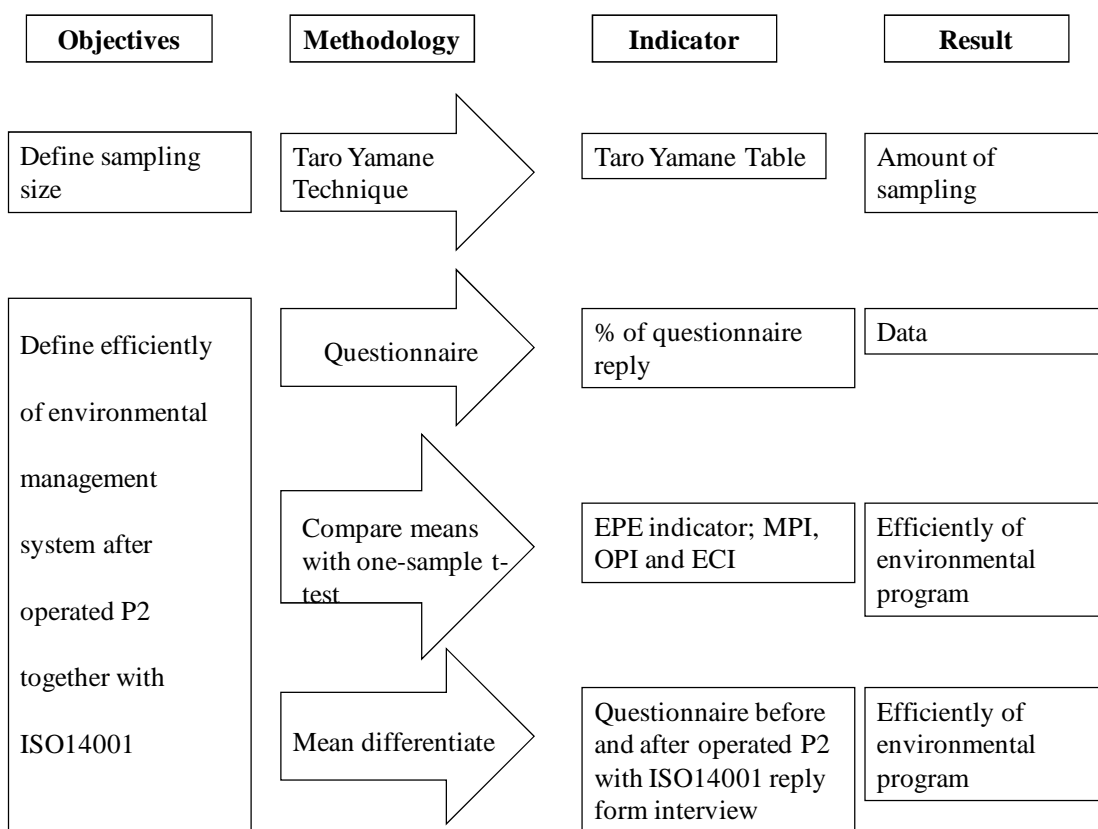
## 2. Survey and interview

This step will be making a questionnaire and send to sampling after got questionnaire back will make an appointment to some company for inquire more details which concerns thesis.

## 3. Data analysis

This step will be collect data and take a questionnaire to processing by SPSS program for compare and summarize results by T-Test.

## 4. Methodology chart



**Figure 4** Methodology chart

## **RESULTS AND DISCUSSION**

This research was been semi-interviews that had been sent questionnaire amount of 315 sets to enterprise where got ISO14001 certification in Thailand. The enterprise had been questionnaire replied to 145 sets or equal to 46.03%, however for getting more detail this research had been interviewed 3 enterprises where different business so all answers were processing by statistical methodology with SPSS software by calculated mean, percentage and compare means with one-sample t test. In order that analysis results can be classification 2 types are general questionnaire result and questionnaire for interview result as follows as summarize.

### **Type 1 General questionnaire result**

The questionnaire of efficiently enhanced environmental management system (ISO14001) by pollution prevention (P2) is including 2 mains data;

- Part1 Initial data

In this part has question to ask about general data and environmental management system performance data.

- Part 2 Efficiently environmental management system (EMS) evaluation data

The research uses Environmental Performance Evaluation (EPE) according to ISO14031 for evaluating efficiently environmental management system (EMS). The questionnaire heading includes 3 issues for evaluating 3 indexes of EPE are

- Management Performance Indicator (MPI)
- Operation Performance Indicator (OPI)
- Environmental Condition Indicator (ECI)

In order that, questionnaire analysis method can be explain as details below.

## Part 1 Initial data analysis

In this part, data is analyzed 2 issues;

### 1.1 General data analysis

The answer in this part was consisted of type of enterprise and size of employee; it was analysis by frequency and percentage. The result can be explained as table 4 and 5.

**Table 4** Type of enterprise

Type of enterprise	Frequency	Valid Percent	Cumulative Percent
Food and beverages	17	11.8	11.8
Natural gas and petrochemical	19	13.2	25.0
Wearing apparel and textiles	12	8.3	33.3
Rubber	1	0.7	34.0
Cement and concrete	4	2.8	36.8
Paper and publishing	6	4.2	41.0
Motor vehicles and autoparts	12	8.3	49.3
Electronics and electrical machinery	39	27.1	76.4
Glass and ceramic	1	0.7	77.1
Others	33	22.9	100.0
Total	144	100.0	

**Remark** A number of sampling loss because any enterprise did not identify type of enterprise so SPSS software cut missing data.

**Table 5** Amount of employee

Amount of employee	Frequency	Valid percent	Cumulative percent
1-50 people	7	4.8	4.8
51-200 people	36	24.8	29.7
> 200 people	102	70.3	100.0
Total	145	100.0	

According to the questionnaire; type of enterprise was classified into 10 types as explained in table 4. The most of enterprises had been replied questionnaire back were 27.1% electronics and electrical machinery, the other enterprises had been replied the questionnaire back were agriculture, beauty, chemical, consume products, engineering service, fiber glass, produce machine, metal and tile.

From table 5 was showed the enterprise interested and replied the questionnaire back 70.3% had employee more than 200 people, 24.8% had employee 51-200 people and 4.8% had employee 1-50% which arranged to large, medium and small enterprise respectively according SMEs definition.

#### SMEs (Small and Medium Enterprises) definition by Thai government

On September 11<sup>th</sup> 2002, the Ministry of Industry introduced the definition of Thai SMEs. This definition is based on the number of salaried workers and fixed capitals. An enterprise is categorized an SME since it has employees less than 200 and fixed capital less than 200 million baht, excluding land and properties. SMEs in Thailand are classified in 3 sections: production, service and trading.

**Table 6** SMEs

Type	Small		Medium	
	Employees	Capital (million baht)	Employees	Capital (million baht)
Production	50 or less	50 or less	51-200	51-200
Service	50 or less	50 or les	51-200	51-200
Wholesale	25 or less	50 or les	26-50	51-100
Retail	15 or less	30 or les	16-30	31-60

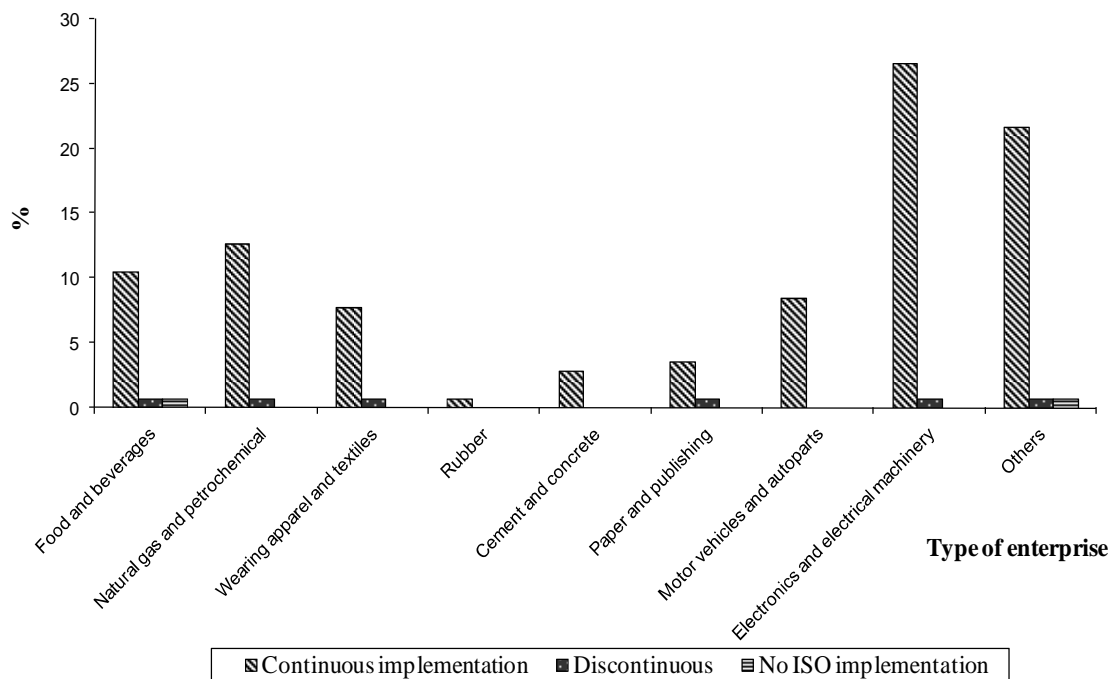
### 1.2 Environmental management system performance data analysis

In this part had answer was concerned continual ISO14001 implementation and P2 tools which used for operated together with ISO14001 therefore all answer were analyzed relation and trend to operated P2 together with ISO14001 by percentage. The result can be explained as table 7 and 8.

**Table 7** Relation of ISO14001 implementation in enterprise in Thailand

Type of enterprise	Type of ISO 14001 implementation			Total
	Continuous implementation	Discontinuous	No ISO implementation	
Food and beverages	10.5%	0.7%	0.7%	11.9%
Natural gas and petrochemical	12.6%	0.7%	0%	13.3%
Wearing apparel and textiles	7.7%	0.7%	0%	8.4%
Rubber	0.7%	0%	0%	0.7%
Cement and concrete	2.8%	0%	0%	2.8%
Paper and publishing	3.5%	0.7%	0%	4.2%
Motor vehicles and autoparts	8.4%	0%	0%	8.4%
Electronics and electrical machinery	26.6%	0.7%	0%	27.3%
Others	21.7%	0.7%	0.7%	23.1%
Total	94.4%	4.2%	1.4%	100.0%

**Relation of ISO14001 implementation in enterprise in Thailand Chart**

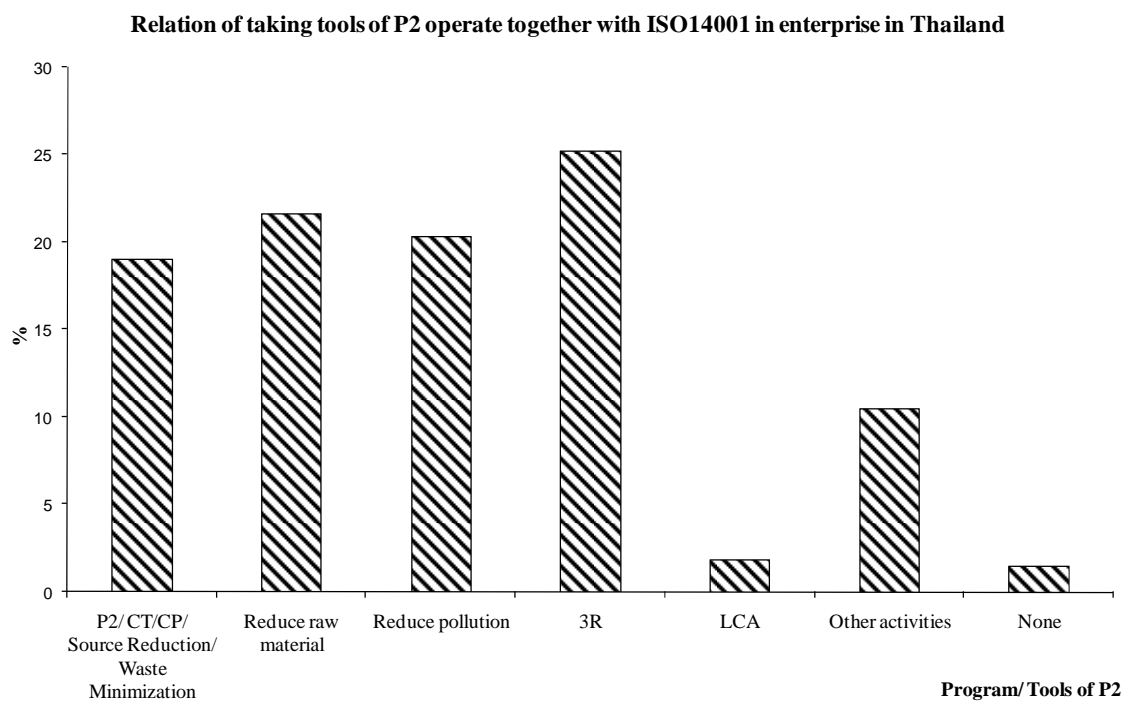


**Figure 5** Relation of ISO14001 implementation in enterprise in Thailand chart

From table as above, 94.4% continuous ISO14001 implementation, 4.2% discontinuous ISO14001 implementation and 1.4% no ISO14001 implementation; food and beverages and the other types were agriculture.

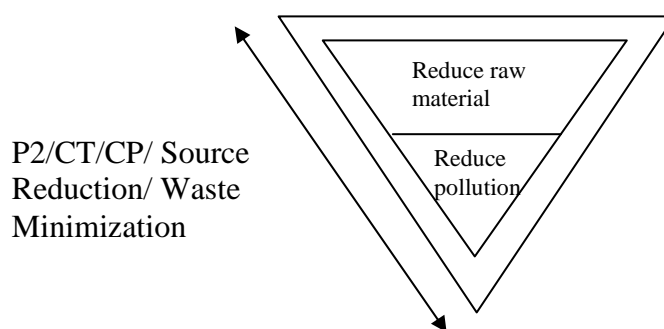
**Table 8** Relation of taking tools of P2 operate together with ISO14001

Program/ Tools of P2	Type of ISO 14001 implementation		
	Continuous implementation	Discontinuous	No ISO implementation
P2/ CT/CP/ Source Reduction/ Waste Minimization	19.0%	28.6%	0%
Reduce raw material	21.6%	7.1%	0%
Reduce pollution	20.3%	28.6%	0%
3R	25.2%	21.4%	0%
LCA	1.8%	0%	0%
Other tools	10.5%	7.1%	0%
None	1.5%	7.1%	100.0%
Total	100.0%	100.0%	100.0%

**Figure 6** A relation of taking tools of P2 operate together with ISO14001 in enterprise in Thailand chart

Almost of enterprise in Thailand had been continual ISO14001 implementation and took tools of P2 operated together too. The P2 had been operated by each enterprise called in different name, after analyzed the questionnaire found tools of P2 had been operated together with ISO14001 in Thailand were 3R, reduce raw material, reduce pollution, P2/CT/CP/source reduction/waste minimization, Other tools (i.e. Kaizen, TPM, Eco design, 5S, Suggestion, Energy conservation, RoHs, Lean, etc.), LCA and none. They had been percentage equal to 25.1%, 21.5%, 20.3%, 19.0%, 10.8%, 1.8% and 1.5% respectively.

From the percentage was showed result of reduce raw material, reduce pollution and P2/CT/ CP/Source Reduction/Waste Minimization had been similar percentages since P2/CT/ CP/Source Reduction/Waste Minimization was focused on efficiently resource management by reduce raw material and pollution therefore the tools which concerned reduce raw material and pollution were been subunit of P2/CT/ CP/Source Reduction/Waste Minimization that explains the relation of program/ tools as figure7.



**Figure 7** Relation of P2/ CT/ CP/ Source Reduction/ Waste Minimization and subunit of tools.

From analysis result as above that found 1.5% of enterprise had been continual ISO14001 implementation but they did not used other tools for operated together with ISO14001, because tools did used in their enterprises were identified in different name of answer choice of questionnaire.

After processing data found the enterprise operated program/ tools which concerned resource management and reduces wastes/ pollution by set team for operation as well as environmental committee and safety, occupational health and working environment committee, moreover management had been support operation by set policy, taking it to been parts of key performance indicator (KPI). The operation was performed comply with company policy and target achievement. For ongoing to achievement they were operation;

- Training all employees to know and awareness to operation.
- Collecting production data for compare it between wastes and products.
- They were production process improvement for reducing raw material.

The benefit of program made them satisfy from waste reduction or reduce pollution treatment, reduce production cost and raise products efficiency.

In order that, almost enterprises in Thailand have been used tools of P2 for operated together with ISO14001 because in the ISO14001 requirement defined pollution of prevention must do for reduce adverse environmental impact, however, this research must knows what P2 program drives efficiently environmental management system according the P2 methodology which assess technique feasibility, economic feasibility and environmental impact.

## **Part 2 Efficiently environmental management system (EMS) evaluation data analysis**

This part was data analysis for evaluating efficiently environmental management system with 3 indexes to identified what P2 is effected to environmental management performance by question as concerns as

- Management Performance Indicator (MPI)
- Operation Performance Indicator (OPI)
- Environmental Condition Indicator (ECI)

The data can analysis and classify result as below.

### 2.1 Management Performance Indicator (MPI) analysis

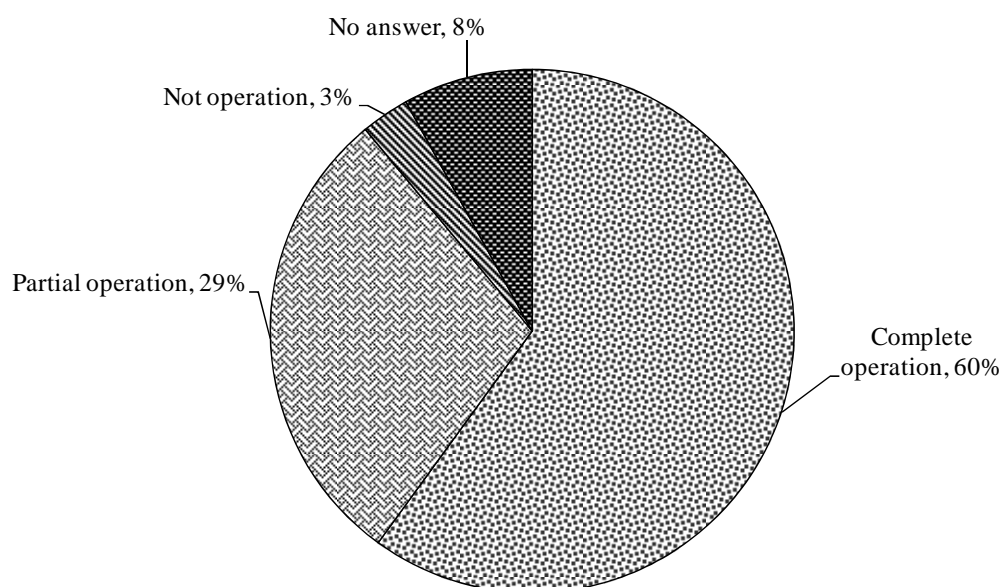
This part has 10 questions and 3 answer choices; not operation, partial operation and complete operation. The question was focused on method of management use for supporting to operated P2 together with ISO14001.

According to enterprise had been questionnaire replied amount of 145 sets. This research had 2 steps to analysis

#### Step1: Data analysis by finding mean

From data analysis found the enterprise in Thailand was selected answer choice of 60% complete operation, 29% partial operation, 3% not operation and 8% no selected answer choice.

**The percentage of selected answer of management performance question chart**



**Figure 8** The percentage of selected answer of management performance question chart

Step2: Data analysis by compare means with one-sample t test

The statistical method used for efficiently enhanced management performance evaluation was analyzed by compare means with one-sample t test. The result can be explained as table 9 and 10.

**Table 9** Management Performance Indicator (MPI) evaluation.

<b>One-Sample Test</b>						
Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
MPI	95.739	121	.000	2.64426	2.5896	2.6989

**Remark** A number of sampling loss because any enterprise was answered question incomplete so SPSS software cut to missing data.

Hypothesis

$H_0$ : P2 is not efficiently enhanced management performance.

$H_1$ : P2 is efficiently enhanced management performance.

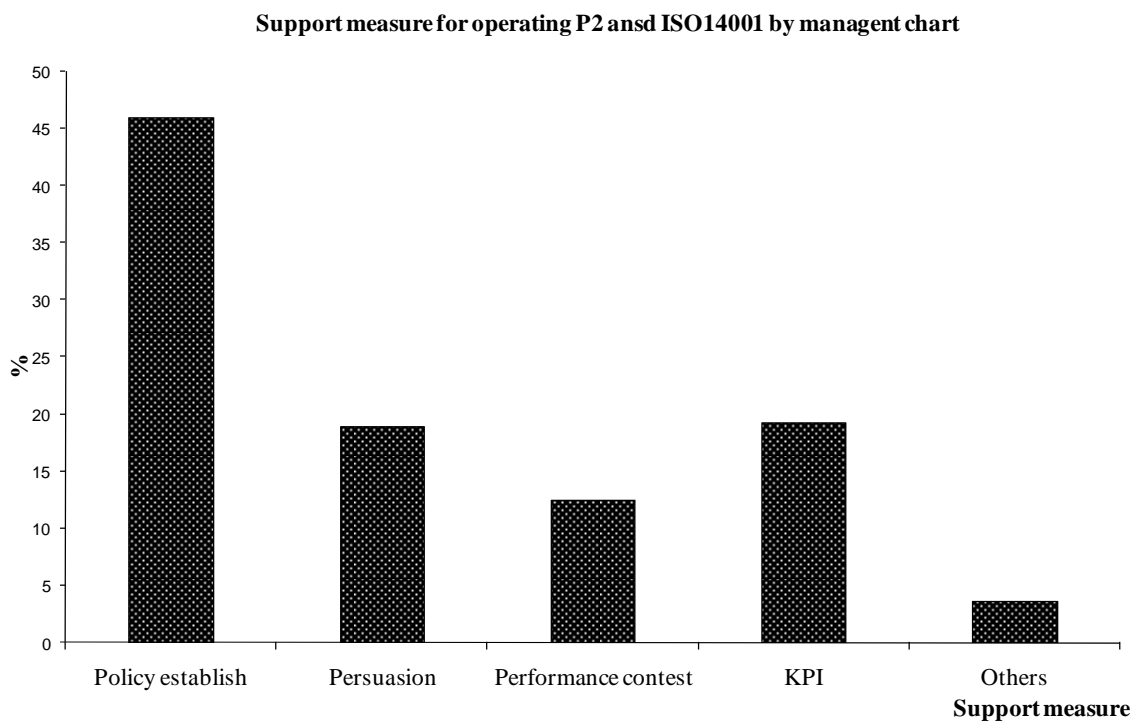
According to the questionnaire replied found any enterprise was not answer some question so when processing data by SPSS software, the system did not read any answer therefore df has value equal to 121.

From table 9 can interpret the result that at t test at 95% confidence interval was reported P value = 0.000 (2-tailed) but the hypothesis as above was 1-tailed so P value = 0,  $\alpha = 0.05$  therefore accept  $H_1$ , P2 is efficiently enhanced management performance that differences exist at statistical level of 0.05 so P2 result could efficiently enhanced environmental management system, EMS.

From questionnaire replied found each enterprise was selected answer choice more than one choice for answer about management way that enterprise used to support to operating P2 together with ISO14001. The result can summarize as table10.

**Table 10** Support measure to operating P2 and ISO14001 by management

Support measure	Responses	
	N	Percent
Policy establish	129	45.9%
Persuasion	53	18.9%
Performance contest	35	12.5%
Key performance indicator (KPI)	54	19.2%
Others	10	3.6%
Total	281	100%



**Figure 9** Support measure for operating P2 and ISO14001 by management chart.

From table 10 and figure 9 was showed management way of enterprise in Thailand used for support to operated P2 together with ISO14001. The measure was they used to support had been reported 45.9% policy establish (ISO14001 requirement defines it in 4.2 environmental policy), 19.2% Key performance indicator (KPI), 18.9% persuasion, 12.5% performance contest and 3.6% others i.e. suggestion, EIA etc..

Enterprise in Thailand liked to operated P2 together with ISO14001 thereby set it to been part of environmental objective and target for using P2 technique to reduce raw material usage and practice comply with both environmental regulations and another regulations which concerned their products as well as RoHs, WEEE and green label.

Furthermore the enterprise was popular used 3R technique to operate in environmental objective and target because of 3R was easily done. However, although they had many management ways to encourage the operation performance as well as employee had important role to operation and informed problem for ongoing the environmental objective and target to achievement.

## 2.2 Operation Performance Indicator (OPI) analysis

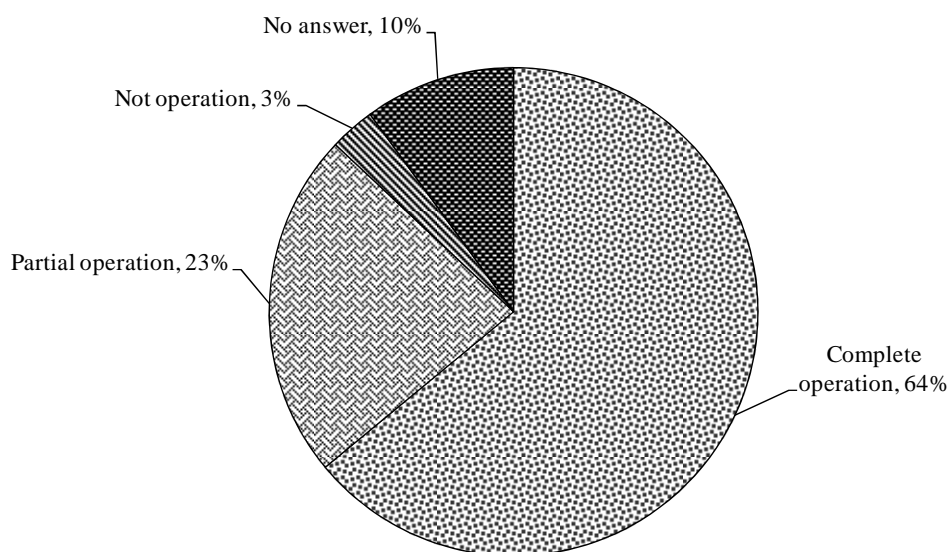
This part has 8 questions and 3 answers choice; not operation, partial operation and complete operation. It used for ask about the operation performance of operated P2 program with ISO14001, these question was focused on operation way used for resource management, reduce pollution and waste and reduce environmental impact.

According to enterprise had been questionnaire replied amount of 145 sets. This research had 2 steps to analysis

### Step1: Data analysis by finding mean

From data analysis found the enterprise in Thailand was selected answer choice of 64% complete operation, 23% partial operation, 3% not operation and 10% no selected answer choice.

**The percentage of selected answer of operating performance question chart**



**Figure 10** The percentage of selected answer of operating performance question chart

**Table 11** Operation Performance Indicator (OPI) evaluation

#### One-Sample Test

Test Value = 0						
				Mean Difference	95% Confidence Interval of the Difference	
t	df	Sig. (2-tailed)	Lower		Upper	
OPI	91.154	116	.000	2.69124	2.6328	2.7497

**Remark** A number of sampling loss because any enterprise was answered question incomplete so SPSS software cut to missing data.

## Hypothesis

$H_0$ : P2 is not efficiently enhanced operating performance

$H_1$ : P2 is efficiently enhanced operating performance

According to the questionnaire replied found any enterprise was not answer some question so when processing data by SPSS software, the system did not read any answer therefore df has value equal to 116.

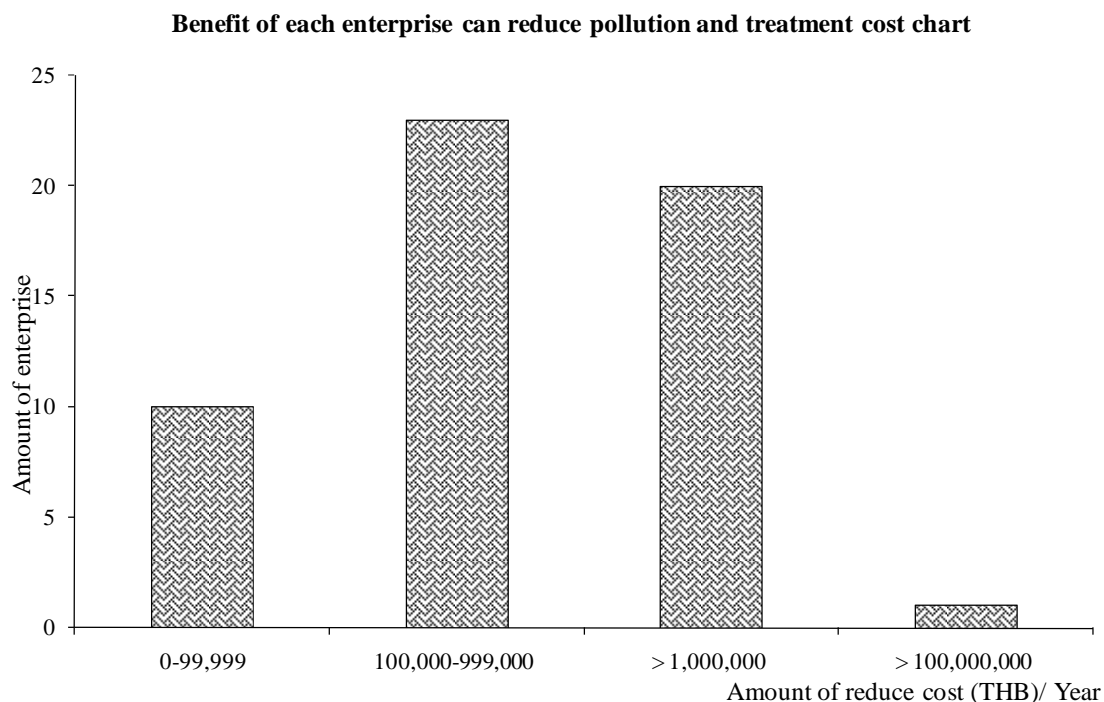
From table 11 can interpret the result that at t test at 95% confidence interval was reported P value = 0.000 (2-tailed) but the hypothesis as above was 1-tailed so P value = 0,  $\alpha = 0.05$  therefore accept  $H_1$ , P2 is efficiently enhanced operating performance that differences exist at statistical level of 0.05 so P2 result could efficiently enhanced environmental management system, EMS.

The popular operation way of each enterprise has been used to enhance efficiently ISO14001 was establish specific committee such as environmental committee.

The example of operation way has been used in production process of enterprise in Thailand such as

- Collecting monthly production data to compare wastes.
- Machine improvement. This method they used after they found the problem which came from machine produced much pollution emission or the production had produce less products.

Therefore their gains from operated P2 together with ISO14001 were encouraged to reduce production cost, pollution and treatment cost. These cost reduction were depending on program and size of each enterprise as illustration as figure 11.



**Figure 11** Benefit of each enterprise can reduce pollution and treatment cost chart

### 2.3 Environmental Condition Indicator (ECI) analysis

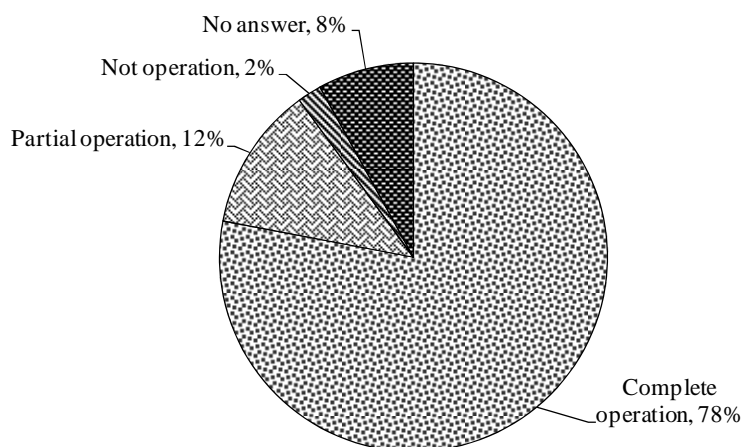
This part has 2 questions and 3 answer choices; not operation, partial operation and complete operation. The question was created for check result of operated P2 program with ISO14001.

According to enterprise had been questionnaire replied amount of 145 sets. This research had 2 steps to analysis

#### Step1: Data analysis by finding mean

From data analysis found the enterprise in Thailand was selected answer choice of 78% complete operation, 12% partial operation, 2% not operation and 38% no selected answer choice.

**The percentage of selected answer of environmental condition question chart**



**Figure 12** The percentage of selected answer of environmental condition question chart

Step2: Data analysis by compare means with one-sample t test

The statistical method used for efficiently enhanced management performance evaluation was analyzed by compare means with one-sample t test. The result can be explained as table 12.

**Table 12** Environmental Condition Indicator (ECI) evaluation

One-Sample Test						
Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
ECI	100.363	130	.000	2.83969	2.7837	2.8957

**Remark** A number of sampling loss because any enterprise was answered question incomplete so SPSS software cut to missing data.

### Hypothesis

$H_0$ : P2 can not reduce pollution as equal than standard.

$H_1$ : P2 can reduce pollution less than standard.

According to the questionnaire replied found any enterprise was not answer some question so when processing data by SPSS software, the system did not read any answer therefore df has value equal to 130.

From table 12 can interpret the result that at t test at 95% confidence interval was reported P value = 0.000 (2-tailed) but the hypothesis as above was 1-tailed so P value = 0,  $\alpha = 0.05$  therefore accept  $H_1$ , P2 can reduce pollution less than standard that differences exist at statistical level of 0.05 so P2 result could efficiently enhanced environmental management system, EMS.

From MPI, OPI and ECI analysis result as above were showed result of operated P2 together with ISO14001 in enterprise in Thailand were encouraged efficiently enhanced environmental management because of to maintain the EMS system they must provide tools for eliminate environmental aspects throughout continually improve an environmental management system.

### **Type 2 Questionnaire for interview analysis result**

For getting more detail to study the efficiently enhanced EMS, this research had been interviewed 3 enterprises that willing to participant to give more information.

The questionnaire in this part is consists question to ask about operating performance before and after operated P2 together with ISO14001. The format of them was separated 2 sections;

Section1: Close ended question is included 3 items for efficiently EMS evaluation both before and after operated P2 together with ISO14001, the heading of question was

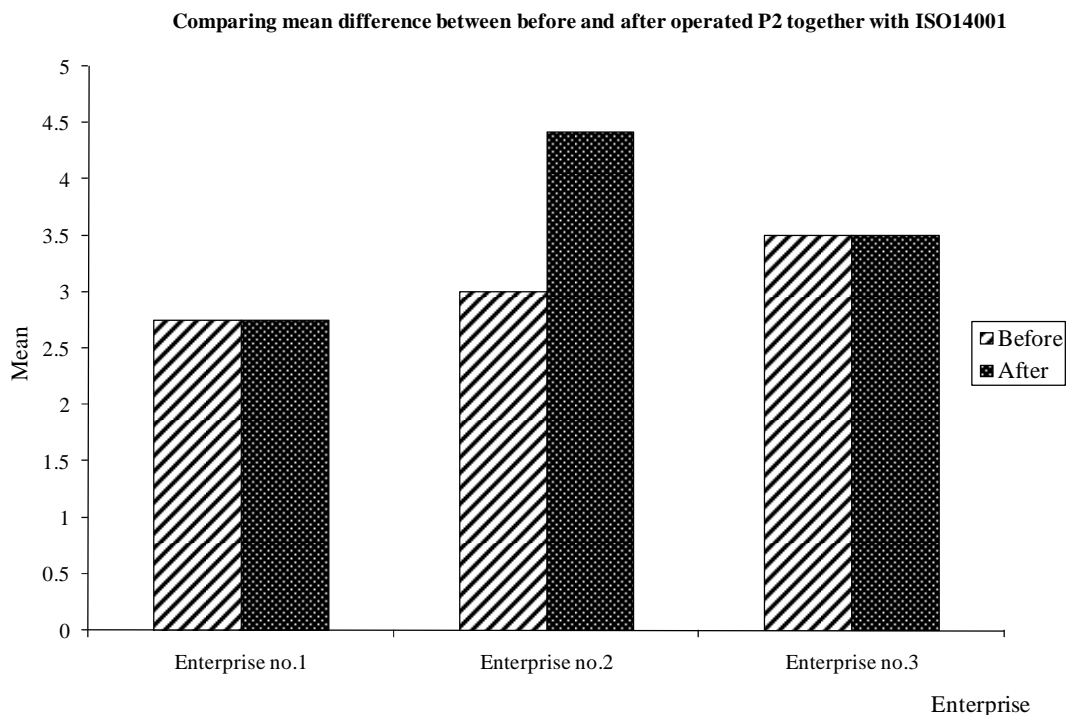
1. Raw material and energy usage question
2. Wastes question
3. Transportation question

Section2: Open ended question is use for ask about operation method which used for ongoing process according to answer of question of section 1.

The answer had been replied from the enterprise could be processing by comparing mean difference before and after operated P2 together with ISO14001. The result can be explained as table 13.

**Table 13** Comparing mean difference between before and after operated P2 together with ISO14001.

<b>Enterprise</b>	Mean before operated P2 together with ISO14001	Mean after operated P2 together with ISO14001
Enterprise no.1	2.75	2.75
Enterprise no.2	3.00	4.42
Enterprise no.3	3.50	3.50



**Figure 13** Comparing mean difference between before and after operated P2 together with ISO14001 chart.

From table 13 and figure 13 were showed different result of mean between before and after operated P2 together with ISO14001 in each enterprise. The result can be explained as below;

#### **- Operating performance of Enterprise no.1 result**

This enterprise has business which concerns produce electronic parts and automotive parts. The enterprise had result of mean not difference between before and after operated P2 together with ISO14001.

To operating P2 together with ISO14001, this enterprise was inserted P2 program in environment objective and target for going to target achievement. Besides that the enterprise was operated P2 program to comply with ISO14001 requirement. 3R (reuse, reduce and recycle) was tools of P2 which enterprise used for operating in environmental objective and target. Although 3R was use in EMS system but it was

failed in production process because of products was produced by reuse raw material had low quality so any technique or tools of P2 is unsuitable for their production process.

### **- Operating performance of Enterprise no.2 result**

This enterprise has business which concerns natural gas and petrochemical. The enterprise had result of mean difference between before and after operated P2 together with ISO14001.

To operating P2 together with ISO14001, this enterprise was provided environmental program such as pollution reduction program, 3R program, energy conservative program, wastes bank program, VOCs reduction program, moreover the enterprise has been taken an interested to operate program by establish team, build awareness to employee and good encourage from top management.

The P2 program was operation both office and production process as explain as an example;

In office used simply tools of P2 such as 3R program, wastes bank program and energy conservative program.

In production process used tools of P2 for operated pollution reduction program, VOCs reduction program. In order that, the operation has been considering process design or change machine to reduce waste and pollution emission. When the process had occurred wastes they improved them by taking wastes back to process or sell or value added them, more over they has been monitoring surrounding and community by set environmental plan and measurement 3 times/ year. After environmental measurement found any area had value of pollution higher than standard they investigated cause, resolved problem and control pollution at source.

### **- Operating performance of Enterprise no.3 result**

This enterprise has business which concerns produce motor vehicle. The enterprise had result of mean not difference between before and after operated P2 together with ISO14001.

To operating P2 together with ISO14001, this enterprise was inserted P2 program in environment objective and target for going to target achievement. Besides that the enterprise was operated P2 program to comply with ISO14001 requirement only.

As interview results as above could not summarize the operating performance after operated P2 together with ISO14001 because of some enterprise was good P2 operation so it was clarified to show the differentiate between before and after operated P2 with ISO14001 but any enterprise had operating result not clear therefore the P2 successful might be depends on type of business and commitment of top management.

From result of general questionnaire and interview has any point opposite since answer might be misunderstand in each question and answer so the information which got from interview was made to more clarify answer from general questionnaire because it made to know about P2 knowledge and some method of enterprise representative in Thailand used for operating together with ISO14001.

# CONCLUSION AND RECOMMENDATION

## Conclusion

According to data analysis with statistical methodology, the result can classify 2 conclusion which concerns the operating performance relation of P2 and ISO14001 as detail as

### 1. General questionnaire conclusion

- Large enterprise has been operated P2 program together with ISO14001 more than medium and small enterprise.

- 3R is P2 tools that enterprise has been taken to operated with ISO14001 more than other tools.

- EPE is evaluation and auditing tools uses for evaluating EMS. The result of indicators evaluation were reported that P2 program could be efficiently enhanced EMS as following summarize as below

- Management Performance Indicator (MPI)

From data analysis by compare means with one-sample t test at 95% confidence interval was reported P value = 0.000 (1-tailed) that shows P2 is efficiently enhanced management performance that differences exist was the statistical level of 0.05

- Operation Performance Indicator (OPI)

From data analysis by compare means with one-sample t test at 95% confidence interval was reported P value = 0.000 (1-tailed) that shows P2 is efficiently enhanced operating performance that differences exist was the statistical level of 0.05.

- Environmental Condition Indicator (ECI)

From data analysis by compare means with one-sample t test at 95% confidence interval was reported P value = 0.000 (1-tailed) that shows P2 can reduce pollution less than standard that differences exist was the statistical level of 0.05.

- P2 was usually included in the policy as EMS requirement
- The benefit of each enterprise got from operated P2 together with ISO14001 was to reduce production cost, reduce pollution and treatment cost.

## **2. Interview conclusion**

- Success of P2 with ISO14001 depends on business type and operation method.
- Any enterprise had mean not difference before and after operated P2 together with ISO14001 because the enterprise has been operated P2 to achieve environment objective and target according ISO14001 requirement.
- 3R was popular techniques which enterprise used to operate together with ISO14001

## **Recommendation**

### **1. Recommendation from ISO14001 auditor**

This research got recommendation from Ms.Darunee Khangkhaket, Audit Division Manager, System Certification Management from Management System Certification Institute (Thailand), Masci, she kindly recommend the research as detail below;

1. According requirement of ISO14001 was defined P2 in requirement; 4.2 environmental policy, (b) includes a commitment to continual improvement and prevention of pollution, therefore enterprise in Thailand always operates P2 to comply with ISO14001 requirement so the questionnaire reply has answer to enhance EMS.

2. According to evaluation indicator which used to evaluate from questionnaire has any enterprise do not know since EPE is not popular in Thailand so the evaluation method of EMS can do it as follows as ISO14001 requirement. The requirement defined 4.5.1 monitoring and measurement and 4.6 management review,

(c) the environmental performance of the organization for evaluating EMS and can do system towards to continual improvement.

## **2. Recommendation from research**

1. P2 program and P2 in requirement of ISO14001 has any method difference because of prevention of pollution in ISO14001 is emphasis on environmental impact evaluation but pollution prevention (P2) program has principle for assess technical feasibility, economic feasibility and environmental impact. However, for prevent misunderstanding to answer should be insert more definition about difference method between P2 in ISO14001 requirement and P2 program.

2. EPE is suitable tools for evaluation the efficiency of EMS therefore ISO14001 auditor should encourage the organization to uses EPE in Thailand.

## **3. Recommendation for next research**

1. The mean different between before and after operated P2 together with ISO14001 did not clear because of amount of interview sampling was less so next research should be add a number of interview sampling both similar business and different business.

2. Recommendation from one ISO14001 auditor might be less information because the research got an idea one side so next research should ask another ISO14001 auditor from many institutes.

3. General questionnaire has less interval answer choice, it made answer error so next research should be add more answer interval than 3 choices.

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## **APPENDICES**

**APPENDIX A**

General Questionnaire translate in English

## **Questionnaire for study efficiently enhanced environmental management system (ISO14001) by pollution prevention**

This questionnaire is part of thesis for study the efficiency of environmental management system in Thailand so please kindly reply them as detail as below.

Explanation: Please marks ✓ on item as your actual operation.

### **Part 1 Initial data**

#### **1. General data**

1.1 Type of enterprise.

- |   |  |
|---|--|
| <input type="checkbox"/> 1. Food and beverages            | <input type="checkbox"/> 6. Paper and publishing                 |
| <input type="checkbox"/> 2. Natural gas and petrochemical | <input type="checkbox"/> 7. Motor vehicles and auto parts        |
| <input type="checkbox"/> 3. Wearing apparel and textiles  | <input type="checkbox"/> 8. Electronics and electrical machinery |
| <input type="checkbox"/> 4. Rubber                        | <input type="checkbox"/> 9. Glass and ceramics                   |
| <input type="checkbox"/> 5. Cement and concrete           | <input type="checkbox"/> 10. Others, please identify.....        |

1.2 Amount of employees.

- 1- 50 people                       51 – 200 people                       > 200 people

#### **2. Environmental management system performance data**

---

##### **Definition**

**ISO14001** is international standard that identify requirement for doing Environmental Management System by set policy, planning, implementation and operation, checking and management review.

**Pollution Prevention (P2)** is technique to using for reduce wastes at source and reduce pollution emission by process improvement for efficiently using resource.

**The phrase as follows has meaning in resource management (raw materials and energy) and reduce wastes or pollution i.e.**

- Pollution Prevention (P2) - Cleaner Technology (CT) - Cleaner Production (CP)
  - Source Reduction                      - Waste Minimization
-

2.1 Does enterprise has ISO14001 implementation?

- Yes
  - Continuous implementation, please identify year (start year to year).....
  - Discontinuous implementation, please identify .....
- No

2.2 What is program/ tool company uses for enhancing environmental management system (excluding ISO14001)? (Answer more one choice)

- Pollution Prevention (P2)/ Cleaner Technology (CT)/ Cleaner Production (CP)/ Waste Minimization
  - Reduce raw material
  - Reduce pollution
- 3R (Reduce, Reuse, Recycling)
- LCA
- Other activities, Please identify .....
- None

---

**If you do activities as following as no. 2.2, please do tables 1 – 3 continue.**

**If you do not have any activities as following as no.2.2, please skip to do other items.**

---

## Part 2 Efficiently environmental management system evaluation

### Appendix Table A1 Management Performance Indicator (MPI)

Explanation: Please marks ✓ on item as your actual operation and define reason in explanation blank.

Detail	Operation level			Please explanation
	Not operation	Partial operation	Complete operation	
1. Enterprise was operated activities as follows as no.2.2 (part1) which not only trading but also focuses on reduces environmental impact.				
2. Enterprise had taken activities as follows no.2.2 (part1) for raw material selection since cradle to grave.				
3. All employees were attended training about environmental and reduce wastes/ pollution.				
4. Enterprise is doing environmental objectives and targets continual by focus on reduce resource and wastes/ pollution. (please explanation)				

Detail	Operation level			Please explanation
	Not operation	Partial operation	Complete operation	
5. Enterprise had been emphasizing to used good quality raw material in process for reduce wastes and less pollution emission at the end. (if you can not operation please explanation)				
6. Enterprise used fewer budgets for wastes/ pollution management after operated activities as follows no.2.2 (part1).				
7. Enterprise could reduce production cost by design or change process to efficiently raw material usage and improved waste to take their back in process. (please explanation)				
8. Enterprise had survey environmental impact from community or who to be concerned very year.				

Detail	Operation level			Please explanation
	Not operation	Partial operation	Complete operation	
9. Enterprise had suggestion activity for environmental management system improvement and reduces wastes/ pollution. (please explanation)				
10. Top management was careful operation activities so the result made the activities on going to achievement.				

### Attitude question

1. What is management method uses for supporting activities as follows no.2.2 (part1) or resource management and reduce wastes/ pollution? (Answer one more choice)

Policy establish

Persuasion

Performance contest

KPI

Others, please identify .....

2. How do you think activities as follows no.2.2 (part 1) helps to raise environmental management system in your enterprise?

Same, please identify .....

Better, please identify .....

Worse, please identify .....

**Appendix Table A2** Operation Performance Indicator (OPI)

Explanation: Please marks ✓ on item as your actual operation and define reason in explanation blank.

Detail	Operation level			Please explanation
	Not operation	Partial operation	Complete operation	
1. Enterprise set special team for resource management and reduces wastes/ pollution which effected to environment.				
2. Enterprise has been collecting production data for compare resource with wastes every day.				
3. Enterprise has been evaluating environmental impact as follow as production process.				
4. Enterprise was problem arrangement by regarding score of KPI (Key Performance Indicator is technique evaluation to uses for operation improvement), budgets and environmental impact.				

Detail	Operation level			Please explanation
	Not operation	Partial operation	Complete operation	
5. Enterprise has been taken environmental aspects that highest effected to environment and human for operating environmental objectives and targets. Activities' result as follows no.2.2 (part1) is push environmental objectives to target achievement.				
6. Enterprise selects way to resolve environmental problem by analyses technique feasibility, break even and decrease environmental impact percentage.				
7. Enterprise had 3R program (Reduce, Reuse and Recycle) for reducing pollution which effected to environment. (please explain reason to select this program)				

Detail	Operation level			Please explanation
	Not operation	Partial operation	Complete operation	
8. Enterprise had redesign production process for reducing pollution emission which effected to environment and health of employee. (please exemplify the way to change production process)				

#### Attitude question

1. Do you think activities as follows no.2.2 (part1) or program of resource management and reduce pollution helps to raise efficiently of ISO14001?

Yes, please identify .....

No, please identify .....

2. How much did you reduce treatment cost in one year after you operated activities as follows no.2.2 (part1) or program of resource management and reduce pollution?  
(please identify monetary unit per year) .....

3. Have you ever received complaint from community or who to be concerned?

Yes, please identify 2 main complaints and exemplify the way to resolve problem.

1.....

2.....

No

**Appendix Table A3** Environmental Condition Indicator (ECI)

Explanation: Please marks ✓ on item as your actual operation and define reason in explanation blank.

Detail	Operation level			Please explanation
	Not operation	Partial operation	Complete operation	
1. Enterprise had compared result of environmental measurement with standard every year.				
2. After operated activities as follows no.2.2 (part1), the result was less pollution value than standard.				

**Attitude question**

1. Do you think activities as follows no.2.2 (part1) or program of resource management and reduce pollution helps to raise reduce pollution?

Yes, reduce .....%

Please explain reason if you want .....

No, please explain reason .....

2. Do you think activities as follows no.2.2 (part1) or program of resource management and reduce pollution helps to encourage good quality of life of employee?

Yes, please explanation .....

No, please explanation .....



4. What is team method uses for operating activity or program of resource management and reduce wastes/ pollution to target achievement? (Answer one more choice)

- Training
- Persuasion
- KPI
- Collecting data for compare products with wastes
- Redesign or change production process
- Use quality raw material for reducing wastes
- Others, please identify .....

5. Is enterprise compare production cost with wastes?

- Yes, enterprise can reduce production cost ..... Baht/ month
- No
- Others, please identify .....

6. What is benefit enterprise gets from activity or program of resource management and reduce wastes/ pollution? (Answer one more choice)

- Reduce production cost
- Reduce treatment cost
- Reduce pollution emission
- Reduce contaction time
- Others, please identify .....
- Reduce complaint
- Efficiently enhance production yield
- Reuse wastes
- Good quality life

7. Do you think activity or program of resource management and reduce wastes/ pollution helps to raise environmental management?

- Yes, please explanation .....
- No, please explanation .....

Thank you for kindly cooperation

**APPENDIX B**

General Questionnaire translate in Thai

**แบบสอบถามการเพิ่มประสิทธิภาพระบบการจัดการสิ่งแวดล้อม ISO14001 ด้วย  
Pollution Prevention (P2)**

เนื่องจากแบบสอบถามนี้เป็นส่วนหนึ่งที่ใช้สำหรับศึกษาวิจัยเพื่อประเมินประสิทธิภาพระบบการจัดการสิ่งแวดล้อมในไทย ดังนั้น จึงขอความกรุณา กับสถานประกอบการของท่านตอบแบบสอบถามดังรายละเอียดด้านล่าง

คำชี้แจง: กรุณาทำเครื่องหมาย ✓ ตามข้อที่ปฏิบัติจริง

**ส่วนที่ 1 ข้อมูลเบื้องต้น**

**1. ข้อมูลทั่วไป**

**1.3 ประเภทสถานประกอบการ**

- |   |   |
|---|---|
| <input type="checkbox"/> 1. ผลิตอาหารและเครื่องคั่ว               | <input type="checkbox"/> 6. ผลิตกระดาษและสิ่งพิมพ์            |
| <input type="checkbox"/> 2. ผลิตน้ำมัน ปิโตรเลียม และแก๊สธรรมชาติ | <input type="checkbox"/> 7. ผลิตยานยนต์                       |
| <input type="checkbox"/> 3. ผลิตเครื่องแต่งกายและสิ่งทอ           | <input type="checkbox"/> 8. ผลิตอุปกรณ์ไฟฟ้าและอิเล็กทรอนิกส์ |
| <input type="checkbox"/> 4. ผลิตยาง                               | <input type="checkbox"/> 9. ผลิตแก้วและเซรามิกส์              |
| <input type="checkbox"/> 5. ผลิตอุปกรณ์ไฟฟ้า และอิเล็กทรอนิกส์    | <input type="checkbox"/> 10. อื่นๆ, โปรดระบุ.....             |

**1.4 ขนาดจำนวนพนักงาน**

- 1- 50 คน                       51 – 200 คน                       > 200 คน

**2. ข้อมูลการจัดทำระบบการจัดการสิ่งแวดล้อม**

**นิยาม**

**ISO14001** คือมาตรฐานสากลที่ระบุข้อกำหนดในการจัดทำระบบการจัดการสิ่งแวดล้อม (Environmental Management System) ด้วยการกำหนดนโยบาย วางแผน นำไปปฏิบัติ ตรวจสอบ แก้ไข และทบทวนโดยฝ่ายบริหาร

**Pollution Prevention (P2)** คือเทคนิคที่ใช้เพื่อลดการเกิดของเสียที่แหล่งกำเนิดและลดมลพิษที่ปล่อยออกสู่สิ่งแวดล้อม โดยการปรับปรุง เปลี่ยนแปลงกระบวนการผลิตให้ใช้ทรัพยากรอย่างมีประสิทธิภาพ

กลุ่มคำดังต่อไปนี้ จัดเป็นคำที่มีความหมายในเชิงการจัดการทรัพยากร (คือวัตถุดิบและพลังงานที่ใช้ในการผลิต) และลดของเสียหรือมลพิษ ได้แก่

- Pollution Prevention (P2) - Cleaner Technology (CT) - Cleaner Production (CP)
- Source Reduction                      - Waste Minimization

## 2.1 บริษัทมีการจัดทำระบบ ISO14001 หรือไม่

- มี โดยเป็นระบบที่มีการจัดทำแบบ
- ต่อเนื่อง โปรระบุปีที่ทำ (เริ่มตั้งแต่ปีใดถึงปีใด) .....
- ไม่ต่อเนื่อง โปรระบุเหตุผล .....
- ไม่มี

## 2.2 บริษัทจัดทำกิจกรรมใดดังต่อไปนี้ (ไม่นับรวม ISO14001) มาเพิ่มประสิทธิภาพระบบการจัดการสิ่งแวดล้อม (ตอบได้มากกว่า 1 ข้อ)

- Pollution Prevention (P2)/ Cleaner Technology (CT)/ Cleaner Production (CP)/ Waste Minimization
- โครงการลดการใช้วัตถุดิบ
- โครงการลดมลพิษ
- โครงการ 3R (Reduce, Reuse, Recycling)
- LCA
- จัดทำกิจกรรมอื่นๆ โปรระบุ .....
- ไม่ได้จัดทำกิจกรรมอื่นใด

---

กรณีจัดทำกิจกรรมตามข้อ 2.2 กรุณาทำตารางที่ 1-3 ต่อ

กรณีไม่ได้ทำกิจกรรมอื่นใดตามที่ระบุในข้อ 2.2 กรุณาข้ามไปทำส่วนเพิ่มเติม

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## ส่วนที่ 2 ข้อมูลวัดประสิทธิภาพระบบการจัดการสิ่งแวดล้อม

### ตารางผนวกที่ B1 ดัชนีวัดผลงานด้านการจัดการ (Management Performance Indicator, MPI)

คำชี้แจง: กรุณาทำเครื่องหมาย ✓ ตามข้อที่ปฏิบัติจริง และระบุเหตุผลได้ในช่องอธิบาย

รายละเอียด	ระดับที่ได้ปฏิบัติ		โปรดใส่ คำอธิบายหาก ต้องการ
	ไม่ได้ปฏิบัติ	ปฏิบัติ บางส่วน ปฏิบัติครบ	
1. บริษัทจัดทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) โดยไม่ได้ทำ ด้วยเหตุผลทางการค้าเท่านั้น แต่มุ่งเน้นที่ลดผลกระทบต่อ สิ่งแวดล้อมเป็นหลัก			
2. บริษัทนำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) มาใช้ตั้งแต่การ คัดเลือกวัตถุดิบตลอดจนถึง การทำลายผลิตภัณฑ์จาก ผู้บริโภค			
3. พนักงานทุกคนได้รับความรู้ เรื่องการจัดการสิ่งแวดล้อม และลดของเสียหรือมลพิษ			
4. บริษัทมีการจัดทำ วัตถุประสงค์ เป้าหมายด้าน สิ่งแวดล้อมอย่างต่อเนื่อง โดยมุ่งเน้นลดการใช้ ทรัพยากรและลดของเสีย หรือมลพิษเป็นหลัก (โปรด ยกตัวอย่าง)			

รายละเอียด	ระดับที่ได้ปฏิบัติ			โปรดใส่ คำอธิบายหาก ต้องการ
	ไม่ได้ปฏิบัติ	ปฏิบัติ บางส่วน	ปฏิบัติครบ	
5. บริษัทเน้นใช้วัตถุดิบที่มี คุณภาพในกระบวนการผลิต ทำให้สามารถลดปริมาณของ เสียและการปล่อยมลพิษที่ ปลายทางน้อยที่สุด (หากไม่ สามารถปฏิบัติได้โปรด อธิบายเหตุผล)				
6. บริษัทใช้งบประมาณจัดการ กับของเสียหรือมลพิษ น้อยลงหลังจากจัดทำ กิจกรรมตามข้อ 2.2 (ส่วนที่ 1)				
7. บริษัทสามารถลดต้นทุนการ ผลิตได้โดยออกแบบ เปลี่ยนแปลงการผลิตให้ สามารถใช้วัตถุดิบอย่างมี ประสิทธิภาพและปรับปรุง ของเสียให้สามารถนำ กลับมาใช้ใหม่ได้ (โปรด ยกตัวอย่าง)				
8. บริษัทมีการสำรวจ ผลกระทบจากชุมชนรอบ ข้างหรือผู้เกี่ยวข้องเป็น ประจำทุกปี				

รายละเอียด	ระดับที่ได้ปฏิบัติ			โปรดใส่ คำอธิบายหาก ต้องการ
	ไม่ได้ปฏิบัติ	ปฏิบัติ บางส่วน	ปฏิบัติครบ	
9. บริษัทมีกิจกรรมให้พนักงาน ร่วมเสนอแนะ เพื่อปรับปรุง ระบบการจัดการสิ่งแวดล้อม และลดของเสียหรือมลพิษ (โปรดยกตัวอย่าง)				
10. การทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) บรรลุผลสำเร็จ ได้ด้วยความใส่ใจและการ ให้การสนับสนุนจาก ผู้บริหาร				

#### แบบสอบถามเกี่ยวกับทัศนคติ

1. ผู้บริหารให้การสนับสนุนกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) หรือโครงการที่เกี่ยวข้องกับการจัดการ  
ทรัพยากรและลดของเสียหรือมลพิษด้วยวิธีใด (ตอบได้มากกว่า 1 ข้อ)

- กำหนดเป็นนโยบายบริษัท  มอบของรางวัลจูงใจ
- จัดกิจกรรมแข่งขันผลงาน  ใช้เป็นส่วนหนึ่งในการประเมินผลงาน
- อื่นๆ โปรดระบุ .....

2. คุณคิดว่าการทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) มีส่วนช่วยทำให้ระบบการจัดการสิ่งแวดล้อมใน  
บริษัทดีขึ้นหรือไม่

- เหมือนเดิม โปรดอธิบายเพิ่มเติม .....
- ดีขึ้น โปรดอธิบายเพิ่มเติม .....
- ไม่ดีขึ้น โปรดอธิบายเหตุผล .....

ตารางผนวกที่ B2 ดัชนีวัดผลงานด้านการปฏิบัติ (Operation Performance Indicator, OPI)

คำชี้แจง: กรณีสทำเครื่องหมาย ✓ ตามข้อที่ปฏิบัติจริง และระบุเหตุผลได้ในช่องอธิบาย

รายละเอียด	ระดับที่ได้ปฏิบัติ			โปรดใส่ คำอธิบายหาก ต้องการ
	ไม่ได้ปฏิบัติ	ปฏิบัติ บางส่วน	ปฏิบัติครบ	
1. บริษัทจัดตั้งทีมเฉพาะเพื่อจัดการทรัพยากร และลดของเสีย หรือมลพิษที่มีผลกระทบต่อสิ่งแวดล้อม				
2. บริษัทเก็บข้อมูลการผลิตวัดปริมาณการใช้วัตถุดิบพลังงานเปรียบเทียบกับผลผลิตและปริมาณของเสียที่เกิดขึ้นทุกวัน				
3. บริษัทประเมินผลกระทบต่อสิ่งแวดล้อมตามขั้นตอนการผลิต				
4. บริษัทจัดลำดับความสำคัญของปัญหาโดยพิจารณาให้คะแนนจาก KPI (Key Performance Indicator คือ การประเมินเทคนิคที่จะใช้ปรับปรุงการปฏิบัติงาน) งบประมาณและผลกระทบต่อสิ่งแวดล้อมเป็นหลัก				

รายละเอียด	ระดับที่ได้ปฏิบัติ			โปรดใส่ คำอธิบายหาก ต้องการ
	ไม่ได้ปฏิบัติ	ปฏิบัติ บางส่วน	ปฏิบัติครบ	
<p>5. บริษัทนำเอาลักษณะปัญหา สิ่งแวดล้อม (Environmental aspect) ที่มีผลกระทบต่อ สิ่งแวดล้อมและคนมากที่สุด มาตั้งเป็นวัตถุประสงค์ เป้าหมายด้านสิ่งแวดล้อม โดยผลของการจัดทำ กิจกรรมตามข้อ 2.2 (ส่วนที่ 1) มีส่วนช่วยให้ วัตถุประสงค์บรรลุเป้าหมาย ที่ตั้งไว้</p>				
<p>6. การเลือกแนวทางแก้ปัญหา สิ่งแวดล้อม วิเคราะห์จาก ความเป็นไปได้ด้านเทคนิค ความคุ้มค่า และเปอร์เซ็นต์ ที่ลดผลกระทบต่อ สิ่งแวดล้อมได้เป็นหลัก</p>				
<p>7. บริษัทมีโครงการ 3R (Reduce/ Reuse/ Recycling) เพื่อลดมลพิษต่อสิ่งแวดล้อม (โปรดระบุเหตุผลที่เลือกใช้ โครงการนี้)</p>				

รายละเอียด	ระดับที่ได้ปฏิบัติ			โปรดใส่ คำอธิบายหาก ต้องการ
	ไม่ได้ปฏิบัติ	ปฏิบัติ บางส่วน	ปฏิบัติครบ	
8. มีการออกแบบกระบวนการ ผลิต ปรับเปลี่ยนวิธีการ ทำงานเพื่อลดการปล่อย มลพิษที่จะกระทบต่อ สิ่งแวดล้อมและสุขภาพของ พนักงาน(โปรดยกตัวอย่าง แนวทางการปรับเปลี่ยน กระบวนการผลิต)				

#### แบบสอบถามเกี่ยวกับทัศนคติ

- คุณคิดว่าการทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) หรือ โครงการที่เกี่ยวข้องกับการจัดการทรัพยากร  
และลดมลพิษมีส่วนช่วยเพิ่มประสิทธิภาพระบบ ISO14001 หรือไม่
  - มี โปรดอธิบายเพิ่มเติม .....
  - ไม่มี โปรดอธิบายเพิ่มเติม .....
- ผลการทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) หรือ โครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลด  
มลพิษสามารถลดค่าใช้จ่ายในการบำบัดของเสียหรือมลพิษได้ประมาณปีละเท่าไร (โปรดระบุเป็น  
หน่วยเงิน / ปี) .....
- ที่ผ่านมามีบริษัทเคยได้รับข้อร้องเรียนจากชุมชนรอบข้าง หรือผู้เกี่ยวข้องหรือไม่
  - เคย โปรดระบุข้อร้องเรียนที่สำคัญ 2 ลำดับแรก พร้อมยกตัวอย่างแนวทางการแก้ปัญหา
    - 1.....
    - 2.....
  - ไม่เคย

ตารางผนวกที่ B3 ดัชนีสถานะแวดล้อม (Environmental Condition Indicator, ECI)

คำชี้แจง: กรุณาทำเครื่องหมาย ✓ ตามข้อที่ปฏิบัติจริง และระบุเหตุผลได้ในช่องอธิบาย.

รายละเอียด	ระดับที่ได้ปฏิบัติ			โปรดใส่ คำอธิบายหาก ต้องการ
	ไม่ได้ปฏิบัติ	ปฏิบัติ บางส่วน	ปฏิบัติครบ	
1. มีการตรวจวัดมลพิษที่ เกิดขึ้นจากกระบวนการผลิต และบริเวณรอบๆ ชุมชน ใกล้เคียง เทียบกับค่า มาตรฐานเป็นประจำทุกปี				
2. ผลจากการทำกิจกรรมตาม ข้อ 2.2 (ส่วนที่ 1) สามารถ ลดมลพิษได้ต่ำกว่าเกณฑ์ มาตรฐาน				

แบบสอบถามเกี่ยวกับทัศนคติ

1. คุณคิดว่าการทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) หรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากร  
และลดของเสียหรือมลพิษมาใช้ร่วมกับ ISO14001 มีส่วนช่วยให้ลดมลพิษได้มากขึ้นหรือไม่

มี ลดได้มากขึ้นประมาณ.....%

โปรดอธิบายเหตุผลหากต้องการ.....

ไม่มี โปรดระบุเหตุผล.....

2. คุณคิดว่าการทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) หรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากร  
และลดของเสียหรือมลพิษมาใช้มีส่วนช่วยลดความเสี่ยงของการสัมผัสมลพิษ ทำให้คุณภาพชีวิต  
ของพนักงานดีขึ้นหรือไม่

มี โปรดอธิบายเพิ่มเติม .....

ไม่มี โปรดอธิบายเพิ่มเติม .....

ส่วนเพิ่มเติม แบบสอบถามเกี่ยวกับการจัดการทรัพยากร (คือวัตถุดิบและพลังงานที่ใช้ในการผลิต) และ  
ลดของเสียหรือมลพิษ (Addition question)

คำชี้แจง: กรุณาทำเครื่องหมาย ✓ ตามข้อที่ปฏิบัติจริง และระบุเหตุผลได้ในช่องอธิบาย.

1. บริษัทมีกิจกรรม หรือ โครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสียหรือมลพิษ  
หรือไม่

มี ได้แก่

กิจกรรมหรือ โครงการที่เกี่ยวข้องกับการจัดการทรัพยากร

กิจกรรมหรือ โครงการที่เกี่ยวข้องกับการลดของเสียหรือมลพิษ

ไม่มีทั้งกิจกรรม หรือ โครงการที่เกี่ยวข้องกับการจัดการทรัพยากร และลดของเสีย  
หรือมลพิษ

ไม่มีกิจกรรม หรือ โครงการใดๆ โปรดอธิบายเพิ่มเติม.....

**กรณีมีกิจกรรม หรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากร และลดของเสียหรือ  
มลพิษ กรุณาตอบข้ออื่นต่อ**

**กรณีไม่มีกิจกรรมหรือ โครงการใดๆ ที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสียหรือ  
มลพิษ สิ้นสุดการตอบแบบสอบถาม**

2. มีการจัดตั้งทีมดำเนินกิจกรรม หรือ โครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสีย  
หรือมลพิษ หรือไม่

มี โปรดระบุ.....

ไม่มี โปรดอธิบายเพิ่มเติม.....

3. ผู้บริหารให้การสนับสนุนกิจกรรม หรือ โครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของ  
เสียหรือมลพิษด้วยวิธีใด

กำหนดเป็นนโยบายบริษัท

มอบรางวัลใจ

จัดกิจกรรมแข่งขันผลงาน

KPI

อื่นๆ โปรดระบุ .....

4. ทีมงานมีวิธีการทำให้กิจกรรม หรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสียหรือมลพิษสำเร็จตามที่ตั้งเป้าหมายได้อย่างไร (ตอบได้มากกว่า 1 ข้อ)

- อบรมให้ความรู้กับพนักงาน
- มอบรางวัลใจ
- ประเมินผลการดำเนินงานเป็นระยะๆ
- เก็บข้อมูลเปรียบเทียบผลการผลิตเทียบกับของเสียที่เกิดขึ้น
- ออกแบบหรือเปลี่ยนแปลงกระบวนการผลิต
- เลือกใช้วัตถุดิบที่มีคุณภาพ เพื่อลดของเสีย
- อื่นๆ โปรดระบุ .....

5. มีการประเมินค่าใช้จ่ายจากผลการผลิตเปรียบเทียบกับปริมาณความสูญเสียที่เกิดขึ้นจากการผลิตหรือไม่

- มี ค่าใช้จ่ายที่เกิดขึ้นลดลงจากเดิมประมาณ..... บาท/เดือน
- ไม่มี
- อื่นๆ โปรดระบุ .....

6. ผลการจัดกิจกรรมหรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสียหรือมลพิษให้ประโยชน์กับบริษัทอย่างไร (ตอบได้มากกว่า 1 ข้อ)

- ลดต้นทุนการผลิต
- ลดข้อร้องเรียนจากชุมชนรอบข้าง
- ลดค่าใช้จ่ายในการบำบัดของเสียหรือมลพิษ
- เพิ่มผลผลิตที่มีประสิทธิภาพ
- ลดการแพร่กระจายของสารเคมีหรือมลพิษ
- สามารถนำของเสียกลับมาใช้ใหม่ได้
- ลดโอกาสการสัมผัสสารเคมี
- สุขภาพชีวิตพนักงานดีขึ้น
- อื่นๆ โปรดระบุ .....

7. คุณคิดว่าการทำกิจกรรมหรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสียหรือมลพิษมีส่วนช่วยให้การจัดการสิ่งแวดล้อมในบริษัทดีขึ้นหรือไม่

- ดี โปรดระบุเหตุผล .....
- ไม่ดี โปรดระบุเหตุผล .....

ขอบคุณทุกท่านที่ให้ความร่วมมือในการตอบแบบสอบถาม

**APPENDIX C**

Questionnaire for interview translate in English

**Questionnaire for study efficiently enhanced environmental management system  
(ISO14001) by pollution prevention**

This questionnaire is part of thesis for study the efficiency of environmental management system in Thailand so please kindly reply them as detail as below.

**Appendix Table C1** Questionnaire of operational successful before operating P2 program together with ISO14001.

Explanation: Please marks ✓ on item as your actual operation and define reason in explanation blank.

Detail	Operation level				
	Not operation	Partial operation but non-continual	Partial operation and continual	Operation completely process but non-continual	Operation completely process and continual improvement
<b>Raw material and energy usage</b>					
1. Enterprise has been re-circulated raw material for reusing in process.					
2. Enterprise could reduce raw material usage and quantity of waste by adjust process.					
3. Enterprise selected alternative energy to use in process.					

<b>Detail</b>	<b>Operation level</b>				
	<b>Not operation</b>	<b>Partial operation but non-continual</b>	<b>Partial operation and continual</b>	<b>Operation completely process but non-continual</b>	<b>Operation completely process and continual improvement</b>
4. Enterprise has been re-circulated water for reusing in process.					
5. Enterprise had design products for extend long life by selecting raw material usage.					
<b>Wastes</b>					
6. Enterprise had wastes separation for takes available wastes reuse in process.					
7. Enterprise had loss evaluation by comparing production every month.					
8. Enterprise had program to reduce cost (please exemplification)					

<b>Detail</b>	<b>Operation level</b>				
	<b>Not operation</b>	<b>Partial operation but non-continual</b>	<b>Partial operation and continual</b>	<b>Operation completely process but non-continual</b>	<b>Operation completely process and continual improvement</b>
9. Enterprise always environmental measurement every year, the result is less impact to environment and living things.					
<b>Transportation</b>					
10. Enterprise chooses another energy to use instead of gasoline for transportation in a day.					
11. Enterprise changed goods transportation way for reducing gasoline usage.					
12. After vehicle improvement, enterprise had less pollution.					

**Appendix Table C2** Questionnaire of operational successful after operated P2  
program together with ISO14001

Explanation: Please marks ✓ on item as your actual operation and define reason in  
explanation blank.

<b>Detail</b>	<b>Operation level</b>				
	<b>Not operation</b>	<b>Partial operation but non- continual</b>	<b>Partial operation and continual</b>	<b>Operation completely process but non- continual</b>	<b>Operation completely process and continual improve- ment</b>
<b>Raw material and energy usage</b>					
1. Enterprise has been re-circulated raw material for reusing in process.					
2. Enterprise could reduce raw material usage and quantity of waste by adjust process.					
3. Enterprise selected alternative energy to use in process.					
4. Enterprise has been re-circulated water for reusing in process.					

<b>Detail</b>	<b>Operation level</b>				
	<b>Not operation</b>	<b>Partial operation but non-continual</b>	<b>Partial operation and continual</b>	<b>Operation completely process but non-continual</b>	<b>Operation completely process and continual improvement</b>
5. Enterprise had design products for extend long life by selecting raw material usage.					
<b>Wastes</b>					
6. Enterprise had wastes separation for takes available wastes reuse in process.					
7. Enterprise had loss evaluation by comparing production every month.					
8. Enterprise had program to reduce cost (please exemplification)					

Detail	Operation level				
	Not operation	Partial operation but non-continual	Partial operation and continual	Operation completely process but non-continual	Operation completely process and continual improvement
9. Enterprise always environmental measurement every year, the result is less impact to environment and living things.					
<b>Transportation</b>					
10. Enterprise chooses another energy to use instead of gasoline for transportation in a day.					
11. Enterprise changed goods transportation way for reducing gasoline usage.					
12. After vehicle improvement, enterprise had less pollution.					

**APPENDIX D**

Questionnaire for interview translate in

**แบบสอบถามการเพิ่มประสิทธิภาพระบบการจัดการสิ่งแวดล้อม ISO14001 ด้วย  
Pollution Prevention (P2)**

เนื่องจากแบบสอบถามนี้เป็นส่วนหนึ่งที่ใช้สำหรับศึกษาวิจัยเพื่อประเมินประสิทธิภาพระบบการจัดการสิ่งแวดล้อมในไทย ดังนั้น จึงขอความกรุณา กับสถานประกอบการของท่านตอบแบบสอบถามดังรายละเอียดด้านล่าง

**ตารางผนวกที่ D1 แบบสอบถามเกี่ยวกับผลสำเร็จของการปฏิบัติงานก่อนทำกิจกรรมตามข้อ 2.2 (ส่วนที่ 1) หรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสียหรือมลพิษ**

คำชี้แจง: กรุณาทำเครื่องหมาย ✓ ตามข้อที่ปฏิบัติจริง และระบุเหตุผลได้ในช่องอธิบาย.

รายละเอียด	ระดับที่ได้ปฏิบัติ				
	ไม่ปฏิบัติ	ปฏิบัติบางส่วน	ปฏิบัติบางส่วน	ปฏิบัติครบ	ปฏิบัติครบ
		แต่ไม่ต่อเนื่อง	อย่างต่อเนื่อง	การแต่ไม่ต่อเนื่อง	และปรับปรุงอย่างต่อเนื่อง
<b>ด้านการใช้วัตถุดิบและพลังงาน</b>					
1. มีการนำวัตถุดิบหมุนเวียนกลับเข้ามาใช้ในการผลิต					
2. มีการปรับเปลี่ยนกระบวนการผลิตที่สามารถลดปริมาณการใช้วัตถุดิบและลดปริมาณของเสีย					
3. มีการเลือกใช้พลังงานอื่นทดแทนในกระบวนการผลิตเพื่อลดปริมาณมลพิษที่ปล่อยออกสู่สิ่งแวดล้อม					

รายละเอียด	ระดับที่ได้ปฏิบัติ				
	ไม่ปฏิบัติ	ปฏิบัติบางส่วนแต่ไม่ต่อเนื่อง	ปฏิบัติบางส่วนอย่างต่อเนื่อง	ปฏิบัติครบการแต่ไม่ต่อเนื่อง	ปฏิบัติครบการและปรับปรุงอย่างต่อเนื่อง
4. มีระบบนำน้ำกลับมาหมุนเวียนใช้ในระบบการผลิต					
5. มีการออกแบบผลิตภัณฑ์เพื่อเลือกใช้วัสดุคืบที่สามารถยืดอายุการใช้งานของผลิตภัณฑ์ได้					
<b>ด้านของเสีย</b>					
6. มีการคัดแยกประเภทของของเสียที่สามารถนำกลับมาเข้ามาใช้ในกระบวนการผลิตใหม่ได้					
7. มีการประเมินค่าความสูญเสียที่เกิดขึ้นจากการผลิตเทียบกับผลผลิตที่ได้เป็นประจำทุกเดือน					
8. มีโครงการหรือกิจกรรมเกี่ยวกับการนำของเสียที่เกิดขึ้นกลับมาเพิ่มมูลค่าให้กับบริษัท หรือช่วยลดค่าใช้จ่ายให้กับบริษัท (โปรดยกตัวอย่าง)					

รายละเอียด	ระดับที่ได้ปฏิบัติ				
	ไม่ปฏิบัติ	ปฏิบัติบางส่วนแต่ไม่ต่อเนื่อง	ปฏิบัติบางส่วนอย่างต่อเนื่อง	ปฏิบัติครบกระบวนการต่อเนื่อง	ปฏิบัติครบกระบวนการปรับปรุงอย่างต่อเนื่อง
9. มีการตรวจวัดมลพิษเป็นประจำทุกปี และค่าที่วัดได้มีผลกระทบต่อสิ่งแวดล้อมและสิ่งมีชีวิต					
<b>ด้านการขนส่ง</b>					
10. มีการเลือกใช้พลังงานอื่นทดแทนน้ำมันเพื่อการขนส่งสินค้าต่อวัน					
11. มีการปรับเปลี่ยนวิธีการขนส่งสินค้าเพื่อลดปริมาณการใช้น้ำมันต่อวัน					
12. มีการตรวจวัดค่ามลพิษที่ปล่อยออกจากยานพาหนะและปรับปรุงไม่ให้มีค่าเกินมาตรฐาน					

ขอบคุณทุกท่านที่ให้ความร่วมมือในการตอบแบบสอบถาม

ตารางผนวกที่ D2 แบบสอบถามเกี่ยวกับผลสำเร็จของการปฏิบัติงานหลังทำกิจกรรมตามข้อ 2.2  
(ส่วนที่ 1) หรือโครงการที่เกี่ยวข้องกับการจัดการทรัพยากรและลดของเสีย  
หรือมลพิษ

คำชี้แจง: กรุณาทำเครื่องหมาย ✓ ตามข้อที่ปฏิบัติจริง และระบุเหตุผลได้ในช่องอธิบาย.

	ระดับที่ได้ปฏิบัติ				
	ไม่ปฏิบัติ	ปฏิบัติบางส่วน	ปฏิบัติบางส่วน	ปฏิบัติตามกระบวนการ	ปฏิบัติตามกระบวนการและปรับปรุงอย่างต่อเนื่อง
รายละเอียด		แต่ไม่ต่อเนื่อง	อย่างต่อเนื่อง	การแต่ไม่ต่อเนื่อง	อย่างต่อเนื่อง
<b>ด้านการใช้วัตถุดิบและพลังงาน</b>					
1. มีการนำวัตถุดิบหมุนเวียนกลับเข้ามาใช้ในการผลิต					
2. มีการปรับเปลี่ยนกระบวนการผลิตที่สามารถลดปริมาณการใช้วัตถุดิบและลดปริมาณของเสีย					
3. มีการเลือกใช้พลังงานอื่นทดแทนในกระบวนการผลิตเพื่อลดปริมาณมลพิษที่ปล่อยออกสู่สิ่งแวดล้อม					
4. มีระบบนำน้ำกลับมาหมุนเวียนใช้ในกระบวนการผลิต					

รายละเอียด	ระดับที่ได้ปฏิบัติ				
	ไม่ปฏิบัติ	ปฏิบัติบางส่วนแต่ไม่ต่อเนื่อง	ปฏิบัติบางส่วนอย่างต่อเนื่อง	ปฏิบัติครบกระบวนการต่อเนื่อง	ปฏิบัติครบกระบวนการปรับปรุงอย่างต่อเนื่อง
5. มีการออกแบบผลิตภัณฑ์เพื่อเลือกใช้วัตถุดิบที่สามารถยืดอายุการใช้งานของผลิตภัณฑ์ได้					
<b>ด้านของเสีย</b>					
6. มีการคัดแยกประเภทของของเสียที่สามารถนำกลับเข้ามาใช้ในกระบวนการผลิตใหม่ได้					
7. มีการประเมินค่าความสูญเสียที่เกิดขึ้นจากการผลิตเทียบกับผลผลิตที่ได้เป็นประจำทุกเดือน					
8. มีโครงการหรือกิจกรรมเกี่ยวกับการนำของเสียที่เกิดขึ้นกลับมาเพิ่มมูลค่าให้กับบริษัท หรือช่วยลดค่าใช้จ่ายให้กับบริษัท (โปรดยกตัวอย่าง)					
9. มีการตรวจวัดมลพิษเป็นประจำทุกปี และค่าที่วัดได้มีผลกระทบต่อสิ่งแวดล้อมและสิ่งมีชีวิต					

	ระดับที่ได้ปฏิบัติ				
	ไม่ปฏิบัติ	ปฏิบัติบางส่วน	ปฏิบัติบางส่วน	ปฏิบัติตามครบ	ปฏิบัติตามครบ
รายละเอียด		แต่ไม่ต่อเนื่อง	อย่างต่อเนื่อง	การแต่ไม่ต่อเนื่อง	กระบวนการและปรับปรุงอย่างต่อเนื่อง
<b>ด้านการขนส่ง</b>					
10. มีการเลือกใช้พลังงานอื่นทดแทนน้ำมันเพื่อการขนส่งสินค้าต่อวัน					
11. มีการปรับเปลี่ยนวิธีการขนส่งสินค้าเพื่อลดปริมาณการใช้น้ำมันต่อวัน					
12. มีการตรวจวัดค่ามลพิษที่ปล่อยออกจากยานพาหนะและปรับปรุงไม่ให้มีค่าเกินมาตรฐาน					

ขอบคุณทุกท่านที่ให้ความร่วมมือในการตอบแบบสอบถาม

**APPENDIX E**

Answer code

**Answer code of general questionnaire of efficiently enhanced environmental  
management system (ISO14001) by pollution prevention**

**Answer code of part 1 initial data**

No	Type	Size	QG1	QG2_1	QG2_2	QG2_3	QG2_4	QG2_5	QG2_6	QG2_7
1	5	1	1	0	2	0	4	0	0	0
2	2	3	1	0	2	3	4	0	0	0
3	3	3	1	1	2	3	4	0	0	0
4	8	2	1	1	2	3	4	0	0	0
5	5	3	1	1	2	0	4	5	6	0
6	2	2	1	1	2	3	4	0	0	0
7	2	3	1	0	0	3	0	0	0	0
8	10	2	1	0	0	0	0	0	6	0
9	7	3	1	1	2	3	4	0	6	0
10	8	3	1	1	2	3	4	0	0	0
11	3	2	1	1	2	3	4	5	0	0
12	6	3	1	0	2	3	0	0	0	0
13	8	3	1	1	2	3	4	0	0	0
14	7	3	1	0	2	3	4	0	0	0
15	7	3	1	0	2	3	4	0	0	0
16	1	3	3	0	0	0	0	0	0	7
17	10	3	1	1	0	0	4	0	0	0
18	5	3	1	0	0	3	4	0	0	0
19	10	2	1	0	0	0	4	0	0	0
20	8	3	1	0	2	3	4	0	0	0
21	8	3	1	1	2	3	4	0	0	0
22	8	2	1	1	2	3	4	0	6	0
23	3	3	2	1	2	3	4	0	6	0
24	2	2	1	1	2	0	4	0	0	0
25	6	3	1	1	2	3	4	0	6	0
26	8	3	1	0	2	0	4	0	0	0
27	10	2	1	1	2	0	4	0	0	0
28	1	3	1	1	0	0	0	0	0	0
29	10	3	1	0	0	3	0	0	0	0
30	7	3	1	1	0	0	4	0	0	0
31	3	3	1	1	2	0	4	0	0	0
32	8	3	1	1	2	0	0	5	6	0
33	7	3	1	0	2	3	4	0	0	0
34	8	3	1	1	2	3	4	0	0	0
35	8	3	1	1	2	3	4	0	6	0
36	10	2	1	1	2	0	4	0	0	0
37	10	3	1	0	2	0	0	0	6	0

No	Type	Size	QG1	QG2_1	QG2_2	QG2_3	QG2_4	QG2_5	QG2_6	QG2_7
38	10	3	1	1	2	3	4	0	0	0
39	8	3	1	0	2	3	0	0	0	0
40	7	3	1	1	2	0	4	0	6	0
41	3	3	1	0	2	3	4	0	0	0
42	2	2	1	0	2	3	0	0	6	0
43	8	3	1	1	2	3	4	0	0	0
44	1	3	1	1	2	3	0	0	0	0
45	1	3	1	1	2	3	0	0	6	0
46	7	2	1	0	0	0	0	0	0	7
47	8	2	1	0	2	3	4	0	0	0
48	3	3	1	1	2	3	0	0	0	0
49	8	3	1	0	2	3	4	0	0	0
50	0	2	1	1	0	3	4	0	0	0
51	8	3	1	1	2	3	4	0	6	0
52	8	3	1	1	2	3	4	0	0	0
53	6	1	2	1	0	3	4	0	0	0
54	10	2	1	0	0	0	4	0	0	0
55	10	3	1	1	2	3	4	0	0	0
56	1	3	1	0	0	3	4	0	0	0
57	10	2	3	0	0	0	0	0	0	7
58	8	3	1	1	2	3	4	0	0	0
59	7	3	1	0	2	0	4	0	0	0
60	1	3	1	1	0	0	0	0	0	0
61	8	3	1	0	0	0	4	0	0	0
62	3	3	1	1	2	3	4	0	0	0
63	1	3	1	1	0	3	4	0	6	0
64	2	3	1	1	2	3	4	5	6	0
65	1	3	1	1	2	3	0	0	0	0
66	2	3	1	1	2	3	4	0	0	0
67	10	3	1	0	2	0	0	0	0	0
68	2	2	1	0	0	3	4	0	0	0
69	2	3	1	1	0	3	4	0	0	0
70	4	3	1	0	2	3	4	0	0	0
71	10	3	1	1	2	0	4	0	0	0
72	8	3	1	0	2	3	4	0	0	0
73	10	1	1	0	0	0	4	0	0	0
74	2	3	1	0	0	0	4	0	0	0
75	8	3	1	0	0	0	4	0	0	0
76	8	3	1	1	0	0	0	0	6	0
77	8	3	1	1	2	0	4	0	6	0
78	10	2	1	0	0	0	4	0	6	0
79	10	3	1	0	0	0	0	0	0	7
80	1	1	2	0	0	0	0	0	0	0

No	Type	Size	QG1	QG2_1	QG2_2	QG2_3	QG2_4	QG2_5	QG2_6	QG2_7
81	10	3	1	0	2	0	0	0	6	0
82	8	3	1	1	2	3	4	0	0	0
83	1	3	1	0	0	0	0	0	0	7
84	3	2	1	1	2	3	4	0	0	0
85	8	3	1	0	0	0	0	0	0	7
86	7	3	1	0	0	0	4	0	0	0
87	8	3	1	0	0	0	4	0	6	0
88	7	2	1	1	0	0	0	0	0	0
89	1	3	1	1	2	3	4	0	6	0
90	1	3	1	1	2	3	4	0	0	0
91	8	3	1	1	2	3	4	0	0	0
92	9	2	0	0	0	0	0	0	6	0
93	8	3	1	0	0	0	4	0	6	0
94	8	3	2	1	0	3	0	0	0	0
95	10	3	1	0	0	3	4	0	0	0
96	10	2	1	1	0	3	4	0	0	0
97	2	2	1	1	0	3	0	0	6	0
98	1	3	1	1	2	3	0	0	6	0
99	3	3	1	0	2	3	4	0	0	0
100	7	2	1	0	0	0	0	0	6	0
101	8	3	1	0	0	0	4	0	0	0
102	8	3	1	1	2	3	4	0	0	0
103	8	3	1	1	2	0	0	0	0	0
104	8	3	1	0	0	0	4	0	0	0
105	8	3	1	0	0	0	4	0	0	0
106	2	3	1	0	0	3	4	0	0	0
107	10	1	1	1	0	3	4	0	0	0
108	3	3	1	0	2	3	4	0	0	0
109	10	3	1	1	2	0	4	0	0	0
110	8	3	1	1	0	3	0	0	0	0
111	1	3	1	0	0	3	0	0	6	0
112	6	2	1	1	2	3	4	0	6	0
113	1	3	1	0	2	0	0	0	0	0
114	10	3	1	0	0	0	4	0	0	0
115	8	3	1	0	2	3	4	0	6	0
116	1	3	1	1	2	3	0	0	6	0
117	5	3	1	0	0	0	4	0	6	0
118	2	2	1	1	2	3	4	0	0	0
119	6	2	1	1	2	3	4	0	6	0
120	1	3	1	1	2	3	4	0	6	0
121	8	3	1	0	0	0	4	0	6	0
122	8	3	1	1	2	3	4	0	6	0
123	2	3	1	1	2	3	4	0	6	0

No	Type	Size	QG1	QG2_1	QG2_2	QG2_3	QG2_4	QG2_5	QG2_6	QG2_7
124	10	2	1	0	0	0	4	0	0	0
125	2	3	1	1	0	3	4	5	6	0
126	10	3	1	0	0	0	0	0	0	7
127	10	2	1	1	0	0	0	0	0	7
128	2	2	1	1	2	0	4	0	6	0
129	10	3	1	0	0	0	0	0	6	0
130	10	1	2	0	0	0	0	0	0	7
131	10	2	1	0	0	0	0	5	6	0
132	3	3	1	0	2	3	4	0	0	0
133	2	2	1	0	2	0	0	0	6	0
134	10	2	1	0	0	0	4	0	0	0
135	3	3	1	1	2	3	4	0	0	0
136	10	2	1	0	2	3	4	0	6	0
137	8	3	1	1	2	3	0	0	0	0
138	10	2	1	1	2	0	0	0	0	0
139	2	1	2	1	0	3	4	0	0	0
140	8	3	1	1	2	3	4	0	0	0
141	10	2	1	1	2	3	4	0	0	0
142	6	3	1	1	2	3	4	0	0	0
143	10	2	1	1	2	0	0	0	6	0
144	2	3	1	0	0	3	4	5	0	0
145	7	3	1	1	0	0	4	0	0	0

## Part 2 Efficiently environmental management system evaluation

### Answer code of appendix table A1: Management Performance Indicator (MPI)

No	QM1	QM2	QM3	QM4	QM5	QM6	QM7	QM8	QM9	QM10
1	2	2	3	3	3	2	2	2	2	2
2	2	2	3	2	2	0	2	2	2	2
3	2	2	3	3	3	3	2	3	3	3
4	2	1	3	3	2	0	0	3	2	0
5	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	2	3	2	3
7	3	3	3	3	3	3	3	3	3	3
8	2	1	3	3	3	3	2	2	2	3
9	3	3	3	3	3	3	3	3	3	3
10	3	2	3	3	3	3	3	1	3	3
11	2	2	3	2	2	2	2	2	2	3
12	3	3	3	3	3	3	3	3	3	3
13	3	3	2	3	3	3	3	2	3	0
14	3	3	3	3	3	3	3	1	2	3
15	2	2	3	2	2	2	2	1	3	3
16	0	0	0	0	0	0	0	0	0	0
17	3	3	3	3	3	3	3	3	3	0
18	3	3	3	3	3	2	2	3	3	3
19	3	2	3	3	2	2	3	1	1	3
20	3	3	3	3	3	3	2	1	2	3
21	2	2	3	3	3	3	3	1	3	3
22	3	3	3	3	3	3	2	3	3	3
23	3	2	3	3	3	3	3	2	3	3
24	3	2	3	3	3	3	1	2	3	0
25	3	3	3	3	3	3	3	3	3	3
26	2	2	2	2	3	2	2	3	3	2
27	3	3	3	3	3	3	3	3	3	3
28	3	3	3	3	3	3	2	2	2	3
29	3	3	3	3	3	3	3	3	3	3
30	2	2	2	2	2	2	2	3	3	2
31	2	2	3	3	2	2	2	2	2	2
32	3	2	2	2	2	2	2	3	2	2
33	3	3	3	3	3	3	3	3	3	3
34	3	3	3	3	3	3	3	3	3	3
35	3	2	3	3	2	3	3	1	3	3
36	3	3	3	3	3	3	3	2	3	3
37	3	2	2	3	3	2	2	3	3	3



No	QM1	QM2	QM3	QM4	QM5	QM6	QM7	QM8	QM9	QM10
81	2	2	3	3	2	2	1	3	3	3
82	2	3	3	3	3	3	2	3	3	3
83	0	0	0	0	0	0	0	0	0	0
84	3	1	3	3	3	2	3	3	3	3
85	0	0	0	0	0	0	0	0	0	0
86	0	2	0	2	2	2	2	3	3	2
87	2	2	2	3	2	3	2	3	2	3
88	2	1	2	3	1	1	2	2	2	2
89	2	2	2	3	2	3	2	2	3	3
90	2	3	3	3	3	2	3	2	3	3
91	3	3	3	3	3	3	2	3	3	3
92	2	2	3	3	3	2	3	3	3	2
93	2	3	2	2	3	2	2	3	3	3
94	2	2	2	2	3	3	2	2	2	3
95	3	2	3	3	3	2	2	3	2	3
96	2	2	3	3	2	2	2	1	2	2
97	3	3	3	3	3	3	2	3	3	3
98	3	2	3	3	2	2	2	2	3	3
99	3	3	3	3	3	3	3	3	3	3
100	2	2	3	3	2	2	2	1	2	2
101	2	2	2	3	2	3	2	2	2	2
102	3	3	3	3	3	3	3	3	3	3
103	2	2	2	2	2	2	2	0	2	2
104	2	2	2	2	2	2	2	2	3	3
105	2	2	2	2	2	2	2	0	3	3
106	2	2	2	2	2	2	2	2	2	2
107	3	2	3	3	1	3	3	3	3	3
108	3	3	3	3	3	2	2	3	3	3
109	3	2	3	3	2	3	3	3	3	3
110	3	3	3	3	3	3	3	3	3	3
111	3	3	3	3	3	3	3	3	3	3
112	3	3	3	3	3	2	3	3	3	3
113	3	3	3	3	3	3	3	3	3	2
114	2	2	3	3	2	2	1	2	2	2
115	3	3	3	3	3	3	3	3	3	3
116	2	1	3	3	2	3	2	3	3	3
117	3	2	3	2	2	1	2	3	3	3
118	3	3	3	3	3	3	3	3	3	3
119	3	3	3	3	3	2	2	3	3	3
120	2	1	3	3	2	3	2	3	3	3
121	3	2	3	3	3	3	2	2	3	3
122	2	2	3	3	3	2	2	2	2	3
123	3	3	2	3	3	0	0	3	3	3

No	QM1	QM2	QM3	QM4	QM5	QM6	QM7	QM8	QM9	QM10
124	3	3	3	3	3	3	3	3	3	3
125	3	3	3	3	3	3	3	3	3	3
126	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0
128	3	3	3	3	2	2	2	3	3	3
129	3	2	2	3	2	2	3	2	2	3
130	0	0	0	0	0	0	0	0	0	0
131	2	3	3	2	3	2	2	1	2	2
132	3	3	3	3	3	3	3	3	3	3
133	3	2	3	3	3	3	3	2	3	3
134	2	1	2	3	2	2	2	1	2	2
135	3	3	3	3	3	3	3	3	3	3
136	2	2	3	3	3	2	2	3	3	3
137	3	3	3	3	3	3	3	3	3	3
138	3	3	3	3	3	3	3	3	3	3
139	2	1	3	2	2	0	0	0	2	0
140	3	2	3	3	2	3	3	1	3	3
141	3	3	3	3	3	2	3	1	2	3
142	3	2	3	3	3	3	3	3	3	3
143	2	2	3	3	3	3	3	2	2	3
144	3	3	3	3	3	3	3	3	3	3
145	3	1	3	3	2	2	3	3	3	3

**Answer code of appendix table A2: Operation Performance Indicator (OPI)**

No	QO1	QO2	QO3	QO4	QO5	QO6	QO7	QO8
1	2	2	3	3	2	1	3	2
2	2	3	3	3	3	3	2	2
3	3	3	3	3	3	3	3	3
4	1	2	3	2	3	2	2	1
5	3	3	3	3	3	3	3	3
6	3	3	3	2	3	2	3	3
7	3	3	3	3	3	3	3	3
8	3	2	3	2	3	3	1	2
9	3	3	3	3	3	3	3	3
10	3	2	3	3	3	3	3	2
11	2	3	2	2	2	2	3	2
12	3	3	3	3	3	3	3	3
13	3	3	3	3	3	3	3	3
14	3	3	3	2	3	3	1	1
15	3	2	3	3	2	2	2	2
16	0	0	0	0	0	0	0	0
17	3	3	3	3	3	3	3	3
18	3	3	3	3	3	3	3	3
19	3	3	3	1	3	3	3	0
20	3	3	2	2	3	2	3	2
21	3	3	3	3	3	3	3	3
22	3	3	3	3	3	3	3	3
23	3	3	3	3	3	3	3	3
24	2	2	3	2	3	3	3	1
25	3	3	3	3	3	3	3	3
26	3	3	2	2	3	3	2	0
27	3	2	3	3	3	3	3	2
28	3	3	3	3	3	3	3	2
29	3	3	3	2	3	3	3	3
30	2	2	3	2	3	3	2	2
31	2	3	2	2	3	2	2	2
32	1	3	3	3	3	3	2	0
33	3	3	3	3	3	3	3	3
34	2	0	3	3	3	2	3	3
35	3	2	3	2	3	3	3	2
36	3	3	3	2	3	3	3	3
37	3	3	3	3	2	2	2	2





No	QO1	QO2	QO3	QO4	QO5	QO6	QO7	QO8
124	3	3	3	3	3	3	3	3
125	3	1	3	2	3	3	3	3
126	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0
128	2	3	3	2	3	2	3	3
129	3	3	3	3	3	3	2	2
130	0	0	0	0	0	0	0	0
131	1	2	2	1	2	2	1	1
132	3	3	3	3	3	3	3	3
133	3	3	3	2	3	3	2	3
134	1	3	3	2	3	3	3	1
135	3	3	3	3	3	3	3	3
136	0	0	0	0	0	0	0	0
137	3	3	3	3	3	3	2	3
138	3	3	3	2	3	3	3	3
139	2	3	2	2	2	3	2	2
140	3	2	3	3	3	3	3	3
141	3	3	3	2	2	2	3	3
142	3	3	3	3	3	3	3	3
143	3	3	3	2	3	2	2	2
144	3	3	3	2	3	2	3	3
145	3	2	3	2	3	3	3	0

**Answer code of appendix table A3: Environmental Condition Indicator (ECI)**

No	QE1	QE2
1	3	2
2	3	3
3	3	3
4	3	3
5	3	3
6	3	3
7	3	3
8	3	2
9	3	3
10	3	3
11	3	3
12	3	3
13	3	3
14	3	3
15	3	2
16	0	0
17	3	3
18	3	3
19	3	3
20	3	3
21	1	0
22	3	3
23	3	3
24	2	3
25	3	3
26	3	3
27	3	3
28	3	3
29	3	3
30	3	2
31	3	3
32	3	3
33	3	3
34	2	2
35	2	3
36	3	3
37	3	2

No	QE1	QE2
38	3	3
39	3	3
40	2	3
41	3	3
42	3	2
43	3	3
44	1	3
45	3	3
46	0	0
47	3	3
48	3	2
49	3	3
50	3	2
51	3	3
52	3	3
53	3	3
54	3	3
55	3	3
56	3	3
57	0	0
58	3	3
59	3	3
60	3	3
61	3	3
62	3	3
63	3	3
64	3	3
65	3	2
66	3	2
67	3	3
68	3	3
69	3	3
70	3	2
71	3	0
72	3	3
73	3	3
74	2	3
75	3	3
76	3	3
77	2	2
78	3	3
79	0	0
80	0	0

No	QE1	QE2
81	3	3
82	3	2
83	0	0
84	3	3
85	0	0
86	3	3
87	3	3
88	3	3
89	2	2
90	2	3
91	3	3
92	3	3
93	3	2
94	2	3
95	3	3
96	3	2
97	3	3
98	3	2
99	3	3
100	3	3
101	1	1
102	3	3
103	0	2
104	1	2
105	2	3
106	3	3
107	3	3
108	3	3
109	3	3
110	3	3
111	3	3
112	3	3
113	3	3
114	3	3
115	3	3
116	3	3
117	3	3
118	3	3
119	3	3
120	3	3
121	3	3
122	3	3
123	3	3

No	QE1	QE2
124	3	3
125	3	3
126	0	0
127	0	0
128	3	3
129	3	3
130	0	0
131	3	3
132	3	3
133	3	2
134	3	3
135	3	3
136	3	2
137	3	3
138	3	3
139	3	0
140	2	3
141	3	2
142	3	3
143	3	3
144	3	3
145	3	2

























**Answer code of questionnaire for interview**

**Answer code of appendix table C1: Operational successful question before operate  
P2 program/ tools together with ISO14001.**

No	Bef_QO1	Bef_QO2	Bef_QO3	Bef_QO4	Bef_QO5	Bef_QO6
1	2	2	1	3	1	3
2	5	2	2	1	5	2
3	2	3	5	5	5	3

No	Bef_QO7	Bef_QO8	Bef_QO9	Bef_QO10	Bef_QO11	Bef_QO12
1	4	1	5	5	5	1
2	2	1	5	5	5	1
3	5	5	5	1	2	1

**Answer code of appendix table C2: Operational successful question after operated  
P2 program/ tools together with ISO14001.**

No	Aft_QO1	Aft_QO2	Aft_QO3	Aft_QO4	Aft_QO5	Aft_QO6
1	2	2	1	3	1	3
2	5	2	5	5	5	5
3	2	3	5	5	5	3

No	Aft_QO7	Aft_QO8	Aft_QO9	Aft_QO10	Aft_QO11	Aft_QO12
1	4	1	5	5	5	1
2	5	5	5	5	5	1
3	5	5	5	1	2	1

**APPENDIX F**  
SPSS software result

**Result of general questionnaire of efficiently enhanced environmental  
management system (ISO14001) by pollution prevention**

**Part 1 Initial data**

**1.1 General data analysis result.**

**Appendix Table F1** Type of enterprise

<b>Statistics</b>		
Type of enterprise		
N	Valid	144
	Missing	6

		<b>Type of enterprise</b>			Cumulative
		Frequency	Percent	Valid Percent	Percent
Valid	Food and beverages	17	11.3	11.8	11.8
	Natural gas and petrochemical	19	12.7	13.2	25.0
	Wearing apparel and textiles	12	8.0	8.3	33.3
	Rubber	1	.7	.7	34.0
	Cement and concrete	4	2.7	2.8	36.8
	Paper and publishing	6	4.0	4.2	41.0
	Motor vehicles and autoparts	12	8.0	8.3	49.3
	Electronics and electrical machinery	39	26.0	27.1	76.4
	Glass and ceramics	1	.7	.7	77.1
	Others	33	22.0	22.9	100.0
	Total		144	96.0	100.0
Missing	0	1	.7		
	System	5	3.3		
	Total	6	4.0		
Total		150	100.0		

**Appendix Table F2** Amount of employees

<b>Statistics</b>			
Amount of employees			
N	Valid	145	
	Missing	5	

<b>Amount of employees</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-50 people	7	4.7	4.8	4.8
	51-200 people	36	24.0	24.8	29.7
	> 200 people	102	68.0	70.3	100.0
	Total	145	96.7	100.0	
Missing	System	5	3.3		
Total		150	100.0		

## 1.2 Environmental management system performance data analysis result

**Appendix Table F3** Relation of ISO14001 implementation in enterprise in Thailand

	<b>Case Processing Summary</b>					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Type of enterprise *	143	95.3%	7	4.7%	150	100.0%
Did you do ISO14001?						

<b>Type of enterprise * Did you do ISO14001? Crosstabulation</b>						
		Did you do ISO14001?				
		Yes, do continual	Yes, do not continual	No	Total	
Type of enterprise	Food and beverages	Count	15	1	1	17
		% within Type of enterprise	88.2%	5.9%	5.9%	100.0%
		% within Did you do ISO14001?	11.1%	16.7%	50.0%	11.9%
		% of Total	10.5%	.7%	.7%	11.9%
Natural gas and petrochemical	Count	18	1	0	19	
		% within Type of enterprise	94.7%	5.3%	.0%	100.0%
		% within Did you do ISO14001?	13.3%	16.7%	.0%	13.3%
		% of Total	12.6%	.7%	.0%	13.3%
Wearing apparel and textiles	Count	11	1	0	12	
		% within Type of enterprise	91.7%	8.3%	.0%	100.0%
		% within Did you do ISO14001?	8.1%	16.7%	.0%	8.4%
		% of Total	7.7%	.7%	.0%	8.4%
Rubber	Count	1	0	0	1	
		% within Type of enterprise	100.0%	.0%	.0%	100.0%
		% within Did you do ISO14001?	.7%	.0%	.0%	.7%
		% of Total	.7%	.0%	.0%	.7%
Cement and concrete	Count	4	0	0	4	
		% within Type of enterprise	100.0%	.0%	.0%	100.0%
		% within Did you do ISO14001?	3.0%	.0%	.0%	2.8%
		% of Total	2.8%	.0%	.0%	2.8%
Paper and publishing	Count	5	1	0	6	
		% within Type of enterprise	83.3%	16.7%	.0%	100.0%
		% within Did you do ISO14001?	3.7%	16.7%	.0%	4.2%
		% of Total	3.5%	.7%	.0%	4.2%
Motor vehicles and autoparts	Count	12	0	0	12	
		% within Type of enterprise	100.0%	.0%	.0%	100.0%
		% within Did you do ISO14001?	8.9%	.0%	.0%	8.4%
		% of Total	8.4%	.0%	.0%	8.4%
Electronics and electrical machinery	Count	38	1	0	39	
		% within Type of enterprise	97.4%	2.6%	.0%	100.0%
		% within Did you do ISO14001?	28.1%	16.7%	.0%	27.3%
		% of Total	26.6%	.7%	.0%	27.3%
Others	Count	31	1	1	33	
		% within Type of enterprise	93.9%	3.0%	3.0%	100.0%
		% within Did you do ISO14001?	23.0%	16.7%	50.0%	23.1%
		% of Total	21.7%	.7%	.7%	23.1%
Total	Count	135	6	2	143	
		% within Type of enterprise	94.4%	4.2%	1.4%	100.0%
		% within Did you do ISO14001?	100.0%	100.0%	100.0%	100.0%
		% of Total	94.4%	4.2%	1.4%	100.0%

**Appendix Table F4** Relation of taking tools of P2 operate together with  
ISO14001

### Case Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
\$P2*QG1	143	95.3%	7	4.7%	150	100.0%

		<b>\$P2*QG1 Crosstabulation<sup>b</sup></b>				
		Did you do ISO14001?				
		Yes, do continual	Yes, do not continual	No	Total	
Program <sup>a</sup>	P2/CT/CP/Source	Count	74	4	0	78
	Reduction/Waste	% within \$P2	94.9%	5.1%	.0%	
	Minimization	% within QG1	19.0%	28.6%	.0%	
		% of Total	18.3%	1.0%	.0%	19.3%
Reduce raw material		Count	84	1	0	85
		% within \$P2	98.8%	1.2%	.0%	
		% within QG1	21.6%	7.1%	.0%	
		% of Total	20.7%	.2%	.0%	21.0%
Reduce pollution		Count	79	4	0	83
		% within \$P2	95.2%	4.8%	.0%	
		% within QG1	20.3%	28.6%	.0%	
		% of Total	19.5%	1.0%	.0%	20.5%
3R		Count	98	3	0	101
		% within \$P2	97.0%	3.0%	.0%	
		% within QG1	25.2%	21.4%	.0%	
		% of Total	24.2%	.7%	.0%	24.9%
LCA		Count	7	0	0	7
		% within \$P2	100.0%	.0%	.0%	
		% within QG1	1.8%	.0%	.0%	
		% of Total	1.7%	.0%	.0%	1.7%
Other tools		Count	41	1	0	42
		% within \$P2	97.6%	2.4%	.0%	
		% within QG1	10.5%	7.1%	.0%	
		% of Total	10.1%	.2%	.0%	10.4%
None		Count	6	1	2	9
		% within \$P2	66.7%	11.1%	22.2%	
		% within QG1	1.5%	7.1%	100.0%	
		% of Total	1.5%	.2%	.5%	2.2%
Total		Count	389	14	2	405
		% of Total	96.0%	3.5%	.5%	100.0%

Percentages and totals are based on responses.

a. Paired group

b. There are not enough (less than 2) multiple response groups for pairing. Percentages are based on responses, but no pairing is performed.

## Part 2 Efficiently environmental management system evaluation

**Appendix Table F5** Management Performance Indicator (MPI)

<b>One-Sample Statistics</b>				
	N	Mean	Std. Deviation	Std. Error Mean
MPI	122	2.6443	.30507	.02762

<b>One-Sample Test</b>						
Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
MPI	95.739	121	.000	2.64426	2.5896	2.6989

**Appendix Table F6** Support measure to operating P2 and ISO14001 by management

<b>\$Support Frequencies</b>				
		Responses		Percent of Cases
		N	Percent	
support measure <sup>a</sup>	Set to policy	129	45.9%	95.6%
	Prize persuade	53	18.9%	39.3%
	Performance contest	35	12.5%	25.9%
	Key Performance Indicator (KPI)	54	19.2%	40.0%
	Other	10	3.6%	7.4%
Total		281	100.0%	208.1%

a. Group

**Appendix Table F7** Operation Performance Indicator (OPI)

<b>One-Sample Statistics</b>						
	N	Mean	Std. Deviation	Std. Error Mean		
OPI	117	2.6912	.31935	.02952		

<b>One-Sample Test</b>						
Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
OPI	91.154	116	.000	2.69124	2.6328	2.7497

**Appendix Table F8** Environmental Condition Indicator (ECI)

<b>One-Sample Statistics</b>				
	N	Mean	Std. Deviation	Std. Error Mean
ECI	131	2.8397	.32384	.02829

<b>One-Sample Test</b>						
Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
ECI	100.363	130	.000	2.83969	2.7837	2.8957

## **CIRRICULUN VITAE**

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