RELATIONSHIP BETWEEN ENVIRONMENTAL PERFORMANCE AND BUSINESS PERFORMANCE OF OIL REFINERY IN SELECTED AEC+6 COUNTRIES

KOKCHHE LIM

A THESIS REPORT SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT
INTERNATIONAL COLLEGE
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG
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THESIS TITLE	Relationship between Environmental Performance and Business Performance of Oil Refineries in Selected AEC+6 Countries
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ABSTRACT

Environmental sustainability management is one of the critical parts to achieve better business performance. Environmental sustainability management is not only focusing on internal green performance, but also develops the whole green supply chain activities in the companies. This paper examines the relationship between Environmental Performance (EP) and Business Performance (BP) of oil refineries in AEC+6 countries. Emission and energy consumption data were used to interpret EP of the refineries. However, improving EP may incur some additional costs. Hence, this paper analyzes the relationship among the Environmental Performance Indicators (EPIs), Return on Equity (ROE), and Return on Asset (ROA) to investigate the impacts of EP on Business Performance (BP). The data were collected from thirteen oil refineries in four different AEC+6 countries namely Korea, Japan, Thailand, and India covering the period of 2012 to 2015. The study found that EPIs of Korea and Japan's refineries are ranked on top, while Thailand and India's refineries have better ROE and ROA. The negative relationship between the emitted sulphur dioxide (SO_2) and BP was also found. The study concludes that refineries should perform well not only in terms of EP, but also social and economic performance.

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Kokchhe Lim

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LIST OF DEFINITIONS

GSCM	Green Supply Chain Management
EP	Environmental Performance
BP	Business Performance
ASEAN	The Association of Southeast Asian Nation
AEC	ASEAN Economic Community
SO_2	Sulphur dioxide
NO_X	Nitrogen oxides
CO_2	Carbon dioxide
TBL	Triple Bottom Lines
CSR	Corporate Social Responsibility
EMS	Environmental Management System
EPI	Environmental Performance Indicator
ISO	International Organization for Standardization
ROE	Return on Equity
ROA	Return on Asset

CHAPTER 1

INTRODUCTION

1.1 Research Background

Presently, society has shown more attention in Green Supply Chain Management (GSCM). The concept of GSCM has two key elements, environmental impacts and resources optimization of firms supply chain. GSCM aims to eliminate the wastege of raw material in the production line, in order to reduce the emissions, energy, and water consumption for compliance the environmental regulation (Chin, Tat, & Sulaiman, 2015). Also, GSCM plays an important role in green purchasing, which is influencing the cost of the operation when making a purchasing decision. Green purchasing is considering on the purchasing activities that including the three R's such as Reduce, Reuse, and Recycle in the operation process as shown in **Figure 1.1** (Salam, 2008).

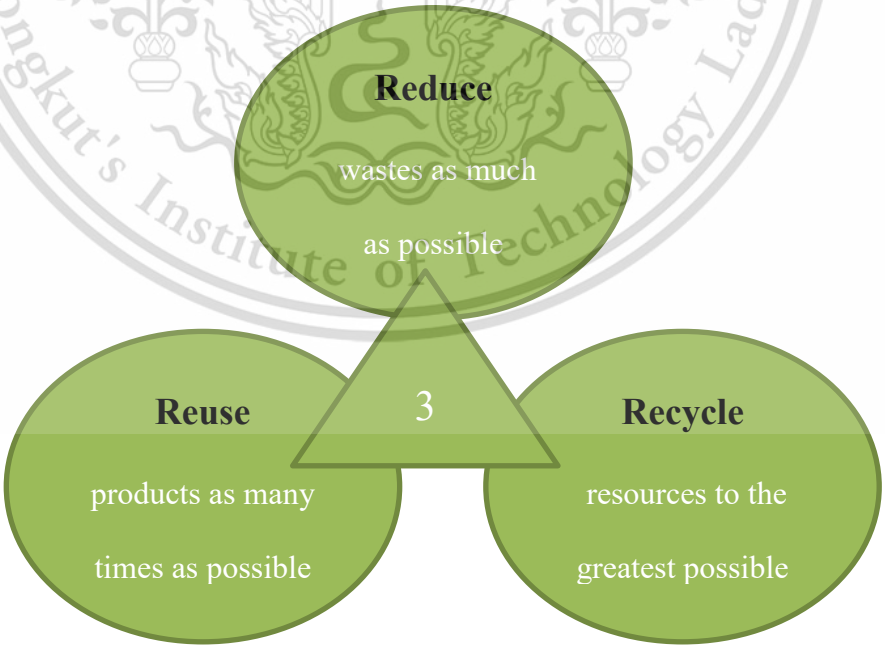


Figure 1.1 3R's diagram

Source: Delaney, 2015

EP deems as one of the important determinant factors for consumer and community's satisfaction as well as green investor. Nowadays, oil refinery is one of the upstream industries that are in the eyes of investors and environmentalists, especially regarding their EP. Thus, the way to increase the BP of this upstream business is part of EP. However, Improving EP might incur some cost and may subsequently impact the cost of downstream businesses as shown in the **Figure 1.2**. Hence, some researchers considered reducing the investment on the environmental project during the crisis time to decrease the cost of operation (Cheney & McMillan, 1990). However, only a few studies have reported on the relationship between EP a businesses' financial performance and reputation.

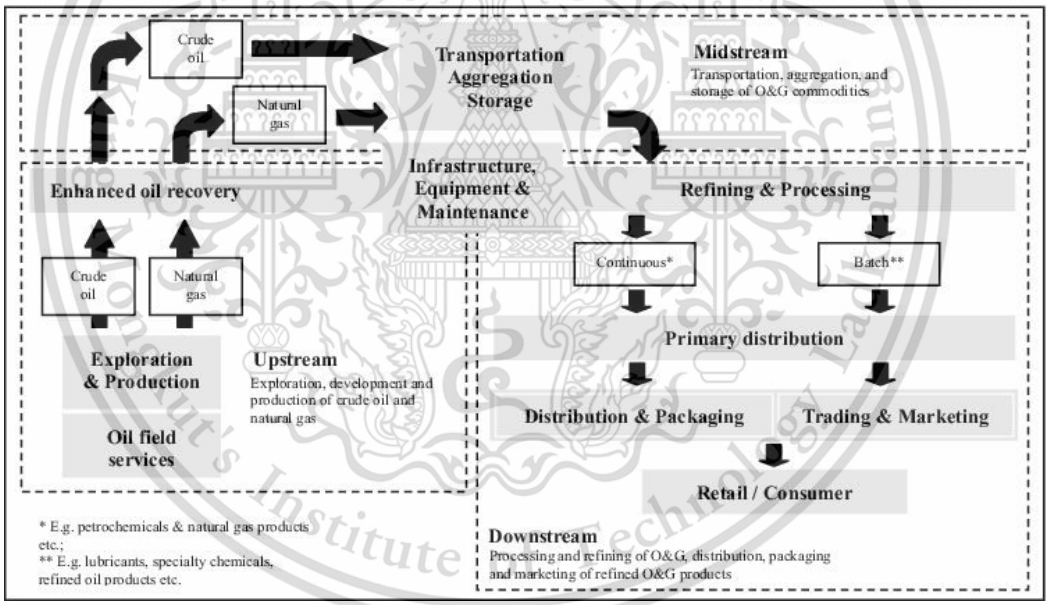


Figure 1.2 Oil and gas supply chain and its industry segments

Source: Energy, Oil & Gas industry update SCOR for energy (KILPONEN, 2010).

Currently, successful businesses can be measured by their achievements such as brand awareness, management quality, sustainability management, and customer loyalty. Many companies are proactive regarding sustainability management, which positions themselves as the leaders in the industry. Thus, the sustainability index has

received great interest from leading the companies today. The sustainability index is a system that measures business performance by not only focus only on companies profit, but also environmental protection. For instance, the Dow Jones Sustainability Indices (DJSI) launched in 1999, aims to measure the sustainability management of companies based on three main factors which include economic, environment and social responsiveness.

1.2 Statement of the Problem

Since energy is important for all business units, oil refinery business is considered as on of the important business sectors in this regard. An oil refinery is one of the upstream businesses that have positions to produce a large volume of energy to support downstream businesses. However, the business processes of this upstream industry had emitted pollution to the environment. The potential environmental impacts that are caused by oil refinery are already well documented. Thus, this study is choosing Energy consumption, Water consumption and Emissions prevented are the important factors to be considered.

ASEAN Economic Community (AEC) had been established to promote the economic and social cooperation among all countries in ASEAN. During the development and trade practices in AEC, which tend to destroy the natural resources and pollute the environment. With the AEC effective, regional trades are facilitated and expected to have higher values. Improvement of EP of refineries, as the upstream businesses, may result in the increase of production cost and impact their Business Performance (BP). This potential cost spike may subsequently impact downstream businesses and supply chains. Thus, there is a need for a study to investigate the

relationship between EP and BP of refineries. The results of the study can be used by decision-makers to justify the upgrade of EP in their refineries.

1.3 Objectives of the Study

The aim of this study is to review sustainable effort and EP of oil refinery in AEC countries. This study also reviews the financial perspective of oil refinery in AEC countries. All of the data information will be used to find the relationship between EP and BP of oil refinery in AEC countries.

1.4 Scope of the Study

Getting the energy that we need affects our environment in many different ways. An oil refinery is defined as the energy industry in this world which received strong global pressure to increase awareness of the environmental impact of the air and water emission. Therefore, this study focuses on five environmental parameters including energy consumption, water consumption, sulphur dioxide (SO_2), nitrogen oxides (NO_X), and carbon dioxide (CO_2) for analysis. Because of oil refineries is one of the huge business industries, which requires huge investments, accurate budget, and also require a partnership to continuous innovation to achieve good performance in business. As a result, this study expands the scope, which includes six more countries such as China, Japan, South Korea, India, Australia and New Zealand, collectively known as the AEC+6.

CHAPTER 2

Literature Review

2.1 Sustainability Management

Today, environmental sustainability has received a lot of attention from many industries. Many organizations have tried to increase their environmental responsibility by investing in newer, greener, and cleaner technologies for their production (Mazzi et al., 2016).

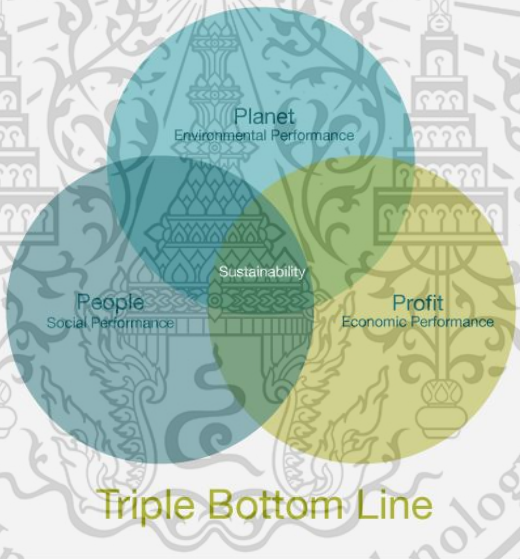


Figure 2.1 Sustainability model Triple Bottom Lines (TBL)

Therefore, Triple bottom line (TBL) sustainable model was created in the year 1994 by John Elkington as shown in **Figure 2.1**. This model incorporates 3Ps including people, profit and planet. People refer to social sustainability, which involves human capital in the companies and suppliers. The aims of this dimension are provide fair and beneficial labour practices in the companies. Previous research suggests that green business may have happier employees (Miranda, 2016). The

second dimension is profit. Profit is the major point for business to survive. It is the economic benefit created by the companies after subtracting the cost of production and cost of the capital. Maximizing profitability and long term sustainable growth are the goals of the companies to survive in the society. Last but not least, the last dimension is a planet, which known as the environmental performance. Companies believe that having better EP will increase their profit. For instance, Horvathova (2010) indicated that there is a positive relationship between EP and FP. It has been improved and paved the way for environmental regulations in the companies for an appropriate period of time. Dixon-Fowler et al. (2013) also suggested that EP has a positive influence on the stock market of the companies. However, there is another study that provides a contrasting idea to the connection above. The study claims that high investment cost on EP will directly impact BP, vice versa (Trumpp & Guenther, 2017a).

Nowadays, investors give high priority to environmental sustainability. The example of environmental sustainability index presented in below.

- Carbon Disclosure Project (CDP): this index helped convince companies all throughout the world to measure and eventually decrease their greenhouse gases emission, water consumption, forest. (Hollande, 2018)
- FTSE4Good: this index launched in 2001 by the FTSE group. It is designed to evaluate the companies that involve international socially responsible investment. (Russell, 2018)
- STOXX Global ESG leaders: The STOXX Global ESG Environmental Leaders index offers a representation of the leading foreign companies in terms of environmental, social and administration criteria, based on ESG

indicators provided by Sustainalytics. This index combined from three ESG sub-indices: (Zurich, 2018a)

  - The STOXX Global ESG Environment Leaders
  - The STOXX Global ESG Social Leaders
  - The STOXX Global ESG Governance Leaders Indics

- OMX GES Sustainability Indexes: The OMX GES Sustainability Indexes are created for responsible investments. The indexes are calculated by NASDAQ OMX in cooperation with GES Investment Services, Northern Europe's leading research and service provider for Responsible Investment. (Nasdaq, 2016)
- Ethibel sustainability index: It is an excellent Global contains a variable numeral of shares from firms that are enclosed in the Russell Global Index and show the best performances in terms of Corporate Social Responsibility (CSR). (Eiris, 2016)
- The Dow Jones Sustainability Indices (DJSI): Driving innovation in the fields of ESG (Environment, Social, and Government) investing. Built on the quality of our rigorous internal analytics and inquiry, we have been pioneers within the improvement, development and application of indices, specifically for utilize by the asset management industry and more broadly in leading the ESG development around the world. (Zurich, 2018b)
- ECPI (sense in sustainability): offering investment and sustainability consultative services characterized by three key ingredients: thematic investment, sustainability, and productivity. (Handelsbanken, 2017)
- The Living Planet Index (LPI): The Living Planet Index (LPI) is a measure of the state of world biological diversity based on population patterns of

vertebrate species from around the world. It does this in much the similar approach that a stock market index tracks the value of a collection of shares or a retail price index tracks the monetary value of a basket of consumer goods (WWF, 2016).

- Environmental Vulnerability Index: This index is designed to be used with economic and social vulnerability indices to supply insights into the strategies that can negatively impact the sustainable development of countries (EVI, 2015).
- Well-Being Index: Well-being is a concept that captures the vital aspects of humans sense and journey of their daily lives — encompassing more than just physical health or economic indicators, well-being includes five components: purpose, social, financial, community, and physical (Allen, 2018).

2.2 Environmental Performance (EP)

There are many previous studies suggesting that suitable environmental performances make smart business sense. Environmental risks and uncertainties are effected on all companies such as investment choice, customer behavior, and government policy (Jones, 2006). Environmental indicators provide a principle knowledge that should be introduced to the objectives of environment responsibility (Díaz-Moreno, 1999). Each indicator ought to be related to specific environmental issues. The indicators of EP are measured from environmental quality of the surrounding corporation (Tocchetto, Pereira, & Tocchetto, 2004).

Currently, environmental pollution is caused by expanding of ordinary business activities. Thus, environmental achievement of business organizations is extremely important in economic activities. It is necessary to encourage companies to

engage in environmental programs such as, waste reduction and efficient use of resources. Other initiatives should be laid on the reduction of environmental burden in production and distribution processes. Therefore, companies should comply with appropriate environmental management systems, which contribute to environmental efforts in the global market (Yamamoto et al., 2003). The environmental performance indicates how organization controls on environmental aspects, where is based on the environmental policy and objectives of the organization on the environmental quality and efficiency of resource used. There are many kinds of management systems, framework, and Environmental performance indicators that use to evaluate the better EP.

2.2.1 Corporate Social Responsibility (CSR)

CSR is one of the accounting concepts that indicate the behavior of the businesses in equitably. CSR also contributes the businesses into economic development while enhancing the quality of life of the customers, employees, communities, investors, government, suppliers, and also society (Purnomo & Widianingsih, 2012; Vena Purnamasari, 2015). Aim of the CSR is fulfilling the good economic result. CSR also explaines the development progress of companies in societies as well as allow company to receive an interest from the green investors (Campbell, 2007; Gouldson, 2006; Margolis & Walsh, 2003; Orlitzky, Schmidt, & Rynes, 2003). On the other hand, CSR plays an important role in the supply chain management that has a significant result on the firm's reputation and long term success (Carter, 2000; Cooper, Frank, & Kemp, 1997; Lysons & Gillingham, 2003). There are many studies suggested that Companies CSR can expand their relationship with the stakeholder more easily (Fiori, Di Donato, & Izzo, 2007; Garriga & Melé, 2004).

2.2.2 Environmental Management System (EMS) ISO 14001

In fact, EMS is known as the legal requirements and knowledge of environmental impacts. The reason for implementing an EMS is motivated by the external factors such as, organization reputation, customer and market advantage, and attracting the green investors (Hillary, 2004). EMS includes the structure of the organization, planning activities, responsibilities, development of the environmental performance, and reviewing the standard of ISO 14001 (Japan Research Institute, 2003). International standard ISO 14001 was officially announced in public in 1996 with 320,000 organizations in 155 countries (Ferrón-Vílchez, 2016). The ISO 14001 is a global international environmental standard that connects with EMS to permit the organization approach and targets. Total certificates of ISO 14001 in year 2016 are indicated in **Table 2.1** below.

Table 2.1 ISO survey of Management System Standard Certifications 2016

Standard	Number of Certificates in 2016	Number of Certificates in 2015	Change	Change in %
ISO 9001	1106356	1034180	72176	7%
ISO 14001	346189	319496	26693	8%
ISO 50001	20216	11985	8231	69%
ISO 27001	33290	27536	5754	21%
ISO 22000	32139	32061	78	0%
ISO/TS 16949	67358	62944	4414	7%
ISO 13485	29585	26255	3330	13%
ISO 22301	3853	3133	720	23%
ISO 20000-1	4537	2778	1759	63%
ISO 28000	356			
ISO 39001	478			
TOTAL	1644357	1520368		8%

Source: International Organization for Standardization, 2017: The ISO Survey of Management System Standard Certifications. https://www.accredia.it/app/uploads/2017/09/ISO_Survey_2016.pdf

Table 2.1 indicates that the number of the companies that join ISO14001 was increased from 319,496 to 346,189 in the year 2015 to 2016, which can be described that ISO 14001 received great interest in the global market. ISO 14001 provides the best practice for organizations that want to achieve good environmental responsibility. In addition, ISO 14001 also provides a framework to control on internal assessments, resource efficiency, recycling, energy consumption reduction and other environmental impacts (Ferrón Vílchez & Darnall, 2016; Nishitani, Kaneko, Fujii, & Komatsu, 2012; Potoski & Prakash, 2005). In addition, study results in AEC showed that adopting ISO 14001 had a positive relationship with BP (Curkovic & Sroufe, 2011; Delmas, 2001; Ferrón Vílchez & Darnall, 2016; Melnyk, Sroufe, & Calantone, 2003). ISO 14001 of AEC+6 countries in the year 2016 shows in **Table 2.2**.

Table 2.2 ISO14001 survey of Management System Standard Certifications 2016 of AEC+6 Countries.

Countries	Number of Certificates in 2015	Number of Certificates in 2016	Change
China	114303	137230	22927
Japan	26069	27372	1303
India	6782	7725	943
Republic of Korea	5436	5009	-427
Australia	4400	4247	-153
Thailand	3051	3458	407
Malaysia	2402	2325	-77
Indonesia	2239	2001	-238
Singapore	1630	1305	-325
Vietnam	1198	1371	173
Philippines	545	1069	524
New Zealand	259	299	40
Brunei Darussalam	30	29	-1
Cambodia	18	22	4
Myanmar	17	13	-4
Lao PDR	6	6	0
TOTAL	168385	193481	25096

Source: International Organization for Standardization, 2017: The ISO Survey of Management System Standard Certifications.

2.2.3 Environmental Performance Index

The environmental performance index is established from joint project lead by the Yale Center for Environmental Law & Policy (YCELP) and Yale Data-Driven environmental Solutions Group at Yale University, the Center for International Earth Science Information Network (CIESIN) at Columbia University. The objectives of the Environmental Performance Index are used to protect human health and maintain

ecosystem vitality. Moreover, The Environmental Performance Index association evaluates companies EP based on ten environmental issues, including Air Quality, Water and Sanitation, Heavy Metals, Biodiversity & Habitat, Forests, Fisheries, Climate and Energy, Air pollution, Water Resources, and Agriculture. The index provides a framework for countries that want to achieve better global sustainability. The Environmental Performance Index framework is shown in **Figure 2.2** below:

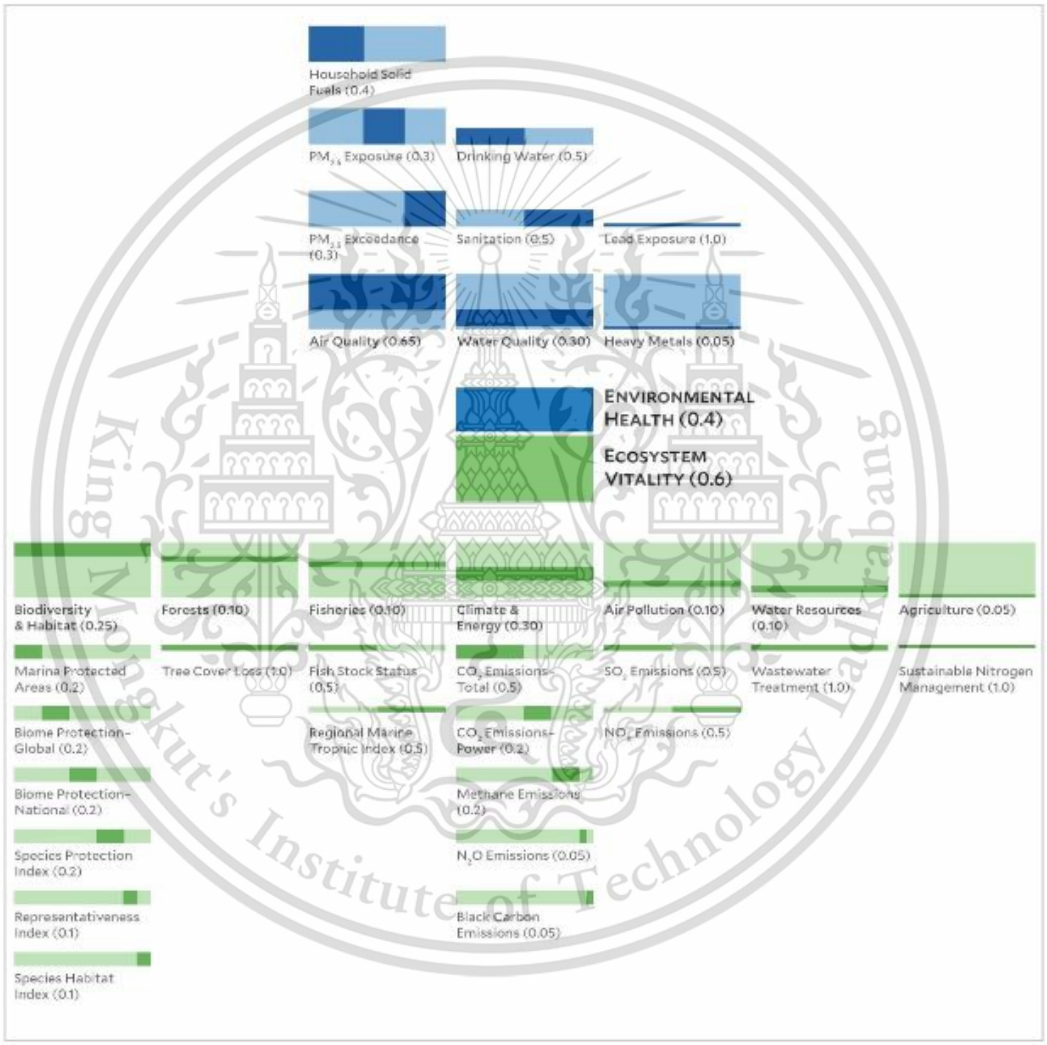


Figure 2.2 Environmental Performance Index Framework in Year 2018

Source: Environmental Performance Index, 2018

Table 2.3 AEC+6 Countries' Ranking in Environmental Performance Index 2018

Rank	Country	2018 EPI Score	Environmental Health	Ecosystem Vitality
17	New Zealand	75.96	95.96	62.63
20	Japan	74.69	92.99	62.48
21	Australia	74.12	97.95	58.23
49	Singapore	64.23	72.14	58.96
53	Brunei	63.57	96.66	41.52
60	South Korea	62.3	72.3	54.96
75	Malaysia	59.22	66.63	54.28
82	Philippines	57.65	55.64	58.99
120	China	50.74	31.72	63.42
121	Thailand	49.88	46.21	52.33
132	Viet Nam	46.96	47.12	46.86
133	Indonesia	46.92	45.44	47.9
138	Myanmar	45.32	35.6	51.8
150	Cambodia	43.23	39.81	45.51
153	Laos	42.94	25.15	54.8
177	India	30.57	9.32	44.74

Source: Environmental Performance Index, 2018 :Ranking country performance on high priority environmental issues.

2.3 Business Performance (BP)

Measuring BP is one of the popular methods for shareholders use to observe in the companies, which based on the accumulated data of financial report. Companies used BP to pursue the result of the companies goals and objectives (Lee, Kim, Seo, & Hight, 2015). According to the previous studies, there are various technique to

evaluate the business performance such as profit, company reputation, and customer loyalty(Madanchian, Hussein, Noordin, & Taherdoost, 2017). However, nowdays companies would like to measure the business performance through two perspectives: financial perspective and nonfinancial perspective.

2.3.1 Financial Perspective

Organization survival depends on the success of the sales growth and operating income. Thus, financial perspective is one of the important factors that use to measure the BP. Financial perspective focuses on the financial performance of the company. It generally covers the income and profit targets of commercial companies as well as the budget and cost-saving targets of companies (Marr, 2018). The financial perspective is recognized for the value of short-term financial results obtained from the examination of economic targets for institutions in the competitive environment (Kaplan & Norton, 2004). In general, organization that have a better BP is looking on the profit mediation. Therefore, measuring the Business Performance mostly based on two main parameters Return on Equity (ROE) and Return on Asset (ROA) (Cohen et al., 1995 & Nakao, 2007).

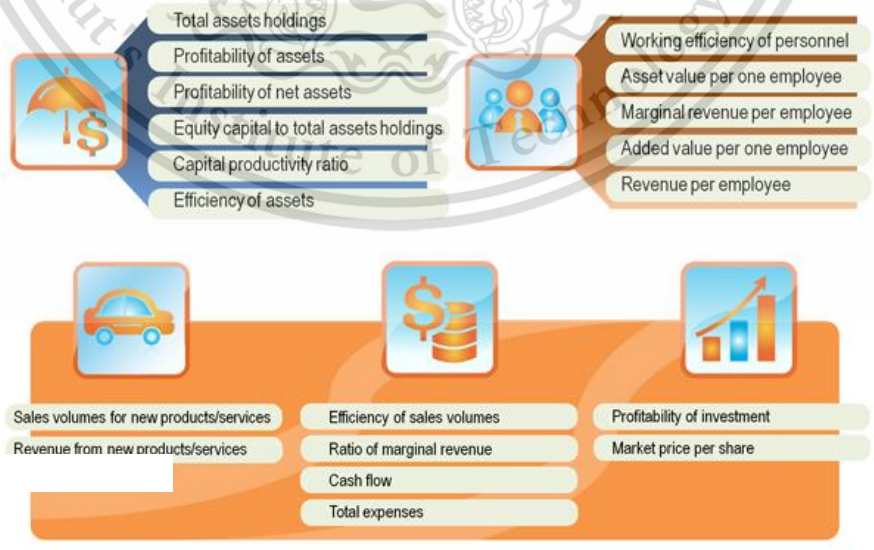


Figure 2.3 Lists of Sample KPIs in Financial Perspective

Source: BSC Designer Team, 2010: List of Sample KPIs in five Perspectives of BSC. https://bscdesigner.com/list-of-sample-kpis-in-5-perspectives-of-bsc.htm

2.3.2 Nonfinancial Perspective

Nonfinancial perspective is referring to the other three perspectives in the balanced scorecard approach, including internal business process, learning and growth, and customer.

- **Internal business process.** Methods that executive uses to evaluate the efficiency of existing business processes.
- **Learning and growth.** Methods that executive uses to evaluate the success of employee training.
- **Customer.** Methods that executive uses to evaluate whether the organization is meeting consumer desires (Kaplan & Norton, 2004).

2.4 Environmental Performance and Business Performance

The connection between EP and BP has grown among the societies. A number of green investors startsed to get interested on the companies that putting more efforts on the EP. Therefore, achieving better EP has turned into the important tools for many economic activities and economic growth. However, EP requires companies to make investments on the structural and social responsibility. These investment requirements would change the production cost and reduce the profitability. Therefore, there are many empirical studies have done to find the relationship between EP and BP. **Table 2.4** will indicate some research studies, which related to EP and BP.

Table 2.4 Research Studies Related to EP and BP

Topic of research study	Results	Resource
Does environmental performance affect financial performance? A meta-analysis	The result of the study indicated the negative link between the EP and FP by using the correlation coefficients. The study suggested that it takes time for the environmental guideline to become a benefit in Financial Performance.	Horváthová, 2010
Beyond "does it pay to be green?" A meta-analysis of moderators of the CEP–CFP relationship	The result of the study was suggested that small firm benefits from environmental performance as much more than large firms, and environmental performance seem to have the strongest influence on market measures of Financial Performance.	Dixon-Fowler, Slater, Johnson, Ellstrand, & Romi, 2013

Topic of research study	Results	Resource
Corporate environmental and economic performance of Japanese manufacturing firms: empirical study for sustainable development	The study found the positive relationship between financial performance indices and EP (CO_2). Reduction of CO_2 might not effect in the short term. However, economic performance can improve from saving on intermediate energy consumption.	Fujii, Iwata, Kaneko, & Managi, 2013
Is environmental management an economically sustainable business?	This study suggested that the company should continuously invest in the Environmental management, which will generate benefits in the long run.	Gotschol, De Giovanni, & Vinzi, 2014
Too Little or too much? Exploring U-shaped Relationships between Corporate Environmental Performance and	This study showed the effect of one theoretical framework “too little of a good thing” (TLGT). The results indicate the	Trumpp & Guenther, 2017b

Topic of research study	Results	Resource
Corporate Financial Performance	negative relationship of Corporate Environmental Performance (CEP) and Corporate Financial Performance (CFP) with the low CEP companies than the high CEP companies.	
The potential of environmental regulation to change managerial perception, environmental management, competitiveness and financial performance	The study suggested that investment in proactive environmental management will contribute to increasing the competitiveness of the firms.	López-Gamero, Molina-Azorín, & Claver-Cortés, 2010
How does environmental performance affect financial performance? Evidence from Japanese manufacturing firms	The result of the study indicated that the waste emission did not have significant with the Financial performance, whereas reducing the GHGs will increase the Financial performance.	Iwata & Okada, 2011

Topic of research study	Results	Resource
How environmental management driving forces affect environmental and economic performance of SMEs: a study in the Northern China district	The study investigated the EP and financial indices in the SME. The result of the study indicated that EP is moderately correlated with financial indices, but not significantly with the non-financial indices.	Zeng et al., 2011
Environmental protection and financial performance: an empirical analysis in Wales	The study illustrated the positive relationship between environmental proactivity and EP. Moreover, the result also indicated the positive effect of environmental performance to the future financial performance.	De Burgos-Jiménez et al., 2013
Revisiting the relationship between environmental and financial performance in Chinese industry	The finding in the study suggested that improving the EP can benefit company FP. Furthermore, assign the	Qi et al., 2014

Topic of research study	Results	Resource
	company environmental management strategy can achieve the advantage of improving both EP and FP.	
Do greenhouse gas emissions affect financial performance?–an empirical examination of Australian public firms	The study found a positive relationship between greenhouse gas emission and financial performance. The study also suggested that companies had low greenhouse gas emission would not benefit financially.	Wang, Li, & Gao, 2014
Competitiveness and environmental performance in Spanish small and medium enterprises: is there a direct link?	The finding suggested that improving the EP will generate a positive influence on the companies by receiving the positive company image and also attracting the green investors.	Jorge, Madueño, Martínez-Martínez, & Sancho, 2015

Topic of research study	Results	Resource
The relationship between environmental performance and financial performance in periods of growth and contraction: evidence from Australian publicly listed companies	The Result of the study indicated that there is a strong positive relationship between CEP and CFP in pre financial crisis period and no relationship in the crisis period.	Muhammad, Scrimgeour, Reddy, & Abidin, 2015

2.4 ASEAN Economic Community (AEC) Background

The Association of Southeast Asian Nation (ASEAN) was established on 8 August 1967 in Bangkok Thailand. There is first five countries to join ASEAN are Indonesia, Malaysia, Philippines, Singapore, and Thailand. ASEAN continued to expand the connection with the other five members:

- Brunei Darussalam joined on 7 January 1984
- Viet Nam joined on 28 July 1995
- Lao PDR and Myanmar joined on 23 July 1997
- The last one is Cambodia joined on 30 April 1999

Figure 2.4 ASEAN Economic Community (AEC countries)

Aims to set up the ASEAN are

- To advertise local peace and strength among all countries in the region
- To step up the economic growth, social responsibility and cultural expansion in the nation which aims to build up the successful and peaceful community in Asian
- To support the education training, research facilities and technical skills among the nation
- To advertise the Southeast Asian Nation countries, maintaining the friendship, and beneficial collaboration in the regions

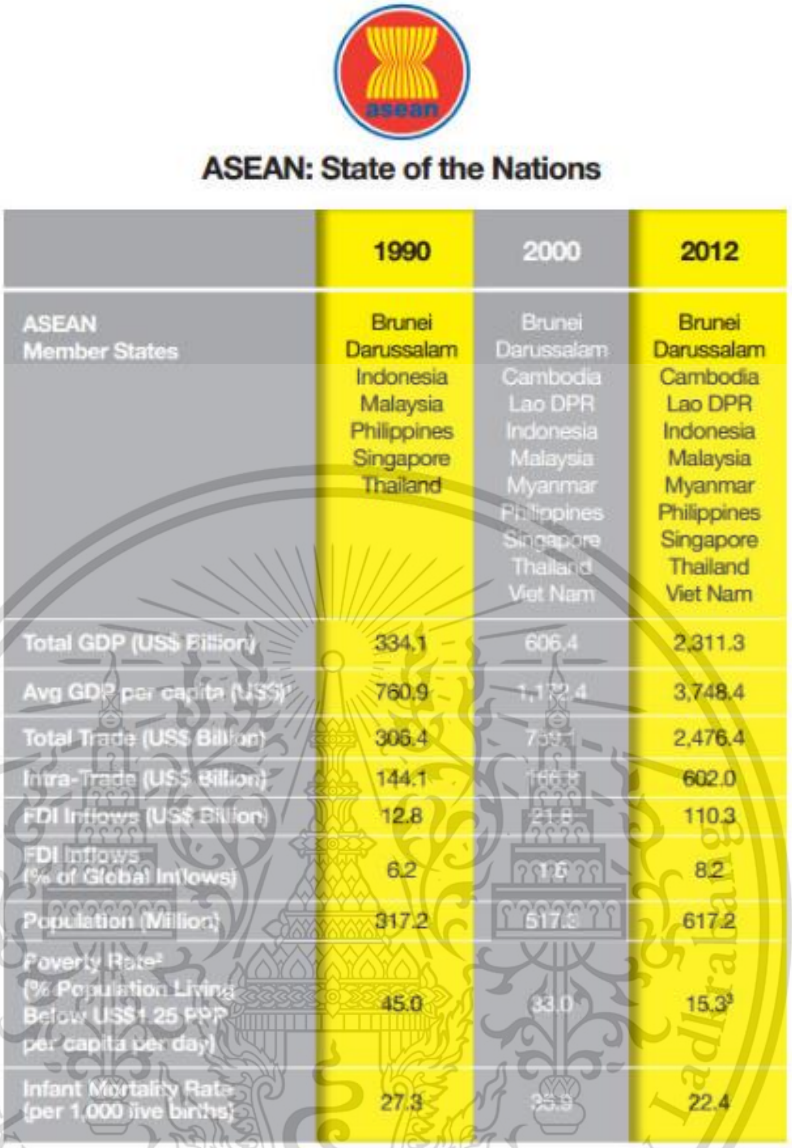


Figure 2.5 Summarizes positive economic and demographic evolution between 1990,2000 and 2012

Source: Thinking Globally Prospering Regionally AEC, 2015: Benefits of the ASEAN Economic Community. https://aseanup.com/benefits-asean-economic-community-aec/

2.4.1 AEC Sustainable Development Goals

The ASEAN Economic Community (AEC) is composed of ten countries in Southeast Asia. To increase the economic and social competitiveness of ASEAN, six more countries in the Asia-Pacific region added, namely, Japan, China, South Korea, India, Australia, and New Zealand, collectively known as the AEC+6. Nowadays, AEC applies a principal influence within the global energy systems (Tongsopit et al.,

2016). However, AEC is facing energy consumption related issues such as sustainable energy production and cost of energy production (Asif & Muneer, 2007; Caraiani et al., 2015; Tongsopit et al., 2016). It was suggested that AEC has to apply the best practices for resolving energy security problems and adopt the international standards to become globally competitive in the future market. There are seventeen sustainable development goals in ASEAN community. Aims of this goals are building efforts to strengthen the standards of living of peoples in the AEC nations (Tijaja, 2017).

- Goal 1: End poverty in all countries in AEC
- Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
- Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- Goal 5: Achieve gender equality and empower all women and girls
- Goal 6: Ensure availability and sustainable management of water sanitation for all
- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all
- Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
- Goal 10: Reduce inequality among countries
- Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable

- Goal 12: Ensure sustainable consumption and production patterns
- Goal 13: Take urgent action to combat climate change and its impacts
- Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- Goal 15: Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, and halt and reverse land degradation, and halt biodiversity loss
- Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels
- Goal 17: Strengthen the means of implementation, and revitalize the global partnership for sustainable development (OECD, 2017)

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Environmental Performance Evaluation

Reducing emission is one of the most important criteria to be adopt by the companies to achieves better FP (Hart & Ahuja, 1996). However, the results are inconclusive whether there is a strong relationship between reducing emission and FP. Some researches argued that increasing investment on EP does not necessarily provide many advantages to FP (Walley & Whitehead, 1994). The research claimed that making investments in environmental projects are costly and will reduce company's profit. This research proposes to use the Environmental Performance Indicator (EPI) as one of the key models to evaluate EP of each refinery.

Environmental Performance Indicator (EPI) adopted from the model suggested by Japan Research Institute in 2003 is used in this study to evaluate EP of each refinery. The parameters used in this study include sulfur dioxide (SO_2), nitrogen oxides (NO_X), carbon dioxides (CO_2), energy and water consumption. These parameters are widely accepted and reported in an annual sustainability report following the Global Reporting Initiative (GRI) guideline. EPIs are calculated by:

$$EPI_i = \frac{Oi}{T} \quad \text{(Eq.1)}$$

Where,

EPI_i= Environmental Performance Indicator of pollution *i*

O_i = Pollution Output i (Gram, m^3, gj, and Ton)

T = Refinery throughput (bbl)

EPI shows the intensity of pollution that each refinery produces per unit of throughput. In the petroleum industry, refinery throughput is the total amount of crude oil processed to produce petroleum products such as LPG, gasoline, kerosene, jet fuel, gas oil, and fuel oil (IPIECA, 2015). Therefore, the lower EPI, the better EP each refinery performs (Reyna-Caamaño, 2001). Data were collected from the GRI and sustainability report of each refinery.

3.2 Business Performance Evaluation

In general, a company's BP is based on its ability to maximize profit. However, BP can also be evaluated based on the different financial indicators set by the companies (Mišanková, 2012). Some previous studies used Return on Equity (ROE) and Return on Asset (ROA) to evaluate BP. For instance, Edwards (1998) used ROE to measure the BP of green organizations, while Hart & Ahuja (1996) used Return on Sale (ROS), ROA, and ROE as a tool to investigate on the relationship of corporate financial performance and corporate social performance. Moreover, Cohen et al (1995) used ROA and ROE to measure the stock performance by looking at the revenue that generate to the common shareholder. A study by Nakao (2007) found that there is a positive impact of the EP on BP, by setting ROE and ROA as a major measurement tool. Meanwhile, Lannelongue et al (2015) found that controlling the EP can reduce the negative impact on the image of the organization and can also increase the profitability of the organization. Based on the previous studies, the relationship between EP and BP appears to be inconclusive.

This study uses ROA and ROE as the parameters to indicate BP of the studied refineries. ROE is the amount of net income returned as a percentage of shareholder's

equity. Return on equity measures a corporation's profitability by revealing how much profit a company generates with the money shareholders has invested.

$$\mathrm{ROE} = \frac{\mathrm{NI}}{\mathrm{E}} \qquad \text{(Eq.2)}$$

Where,

ROE = Return on Equity

NI = Net Income

E = Stockholders' Equity

ROA is an indicator of how profitable a company is relative to its total assets. ROA gives an idea how efficient management is at using its assets to generate earnings. ROA is sometimes showed as a percentage referred to as "return on investment" (McClure, 2005). These values are obtained from the companies' annual report.

$$\mathrm{ROA} = \frac{\mathrm{NI}}{\mathrm{TA}} \qquad \text{(Eq.3)}$$

Where,

ROA = Return on Assets

NI = Net Income

TA = Total Asset

3.3 Data Collection and Limitation

EPI data used in this report are collected from latest sustainability report in Global Reporting initiative (GRI) and DJSI databases from 2012 to 2015. However, all the data collected is only from the oil refineries which are the member in GRI and DJSI. Thirteen samples are comprised of 4 countries of Thailand, Japan, South Korea

and India to use for evaluating EPI due to limitation of available data. Moreover, all BP data collections extract from oil refineries yearly report, which is published every year in their company's database.

3.4 Correlation Coefficient between EP and BP

In order to analyze the relationship between EP and BP, this study uses correlation coefficient to describe the results. A correlation coefficient is a tool used to find the relationship between the two variables. It yields a result value from a range of $-1 \leq 0 \leq 1$, with negative and positive values, indicating negative and positive relationships, respectively (Cohen, Fenn, & Naimon, 1995).

Table 3.1 Guidelines for interpreting strength of the correlation

Interpreting a correlation coefficient	
Correlation Value	**Interpretation**
<= 0.30	Very low
0.3 to 0.5	Normal
0.5 to 0.9	High
The same guidelines apply for negative values of r	

There are many studies conducted that attempted to identify the relationship between EP and BP, however they came up with inconclusive viewpoints. This paper analyses EP by examining five environmental parameters including SO_2, NO_x, CO_2, energy consumption, and water consumption, while ROE and ROA are used to indicate BP. This research study uses R programing to find the relationship between BP and EP.

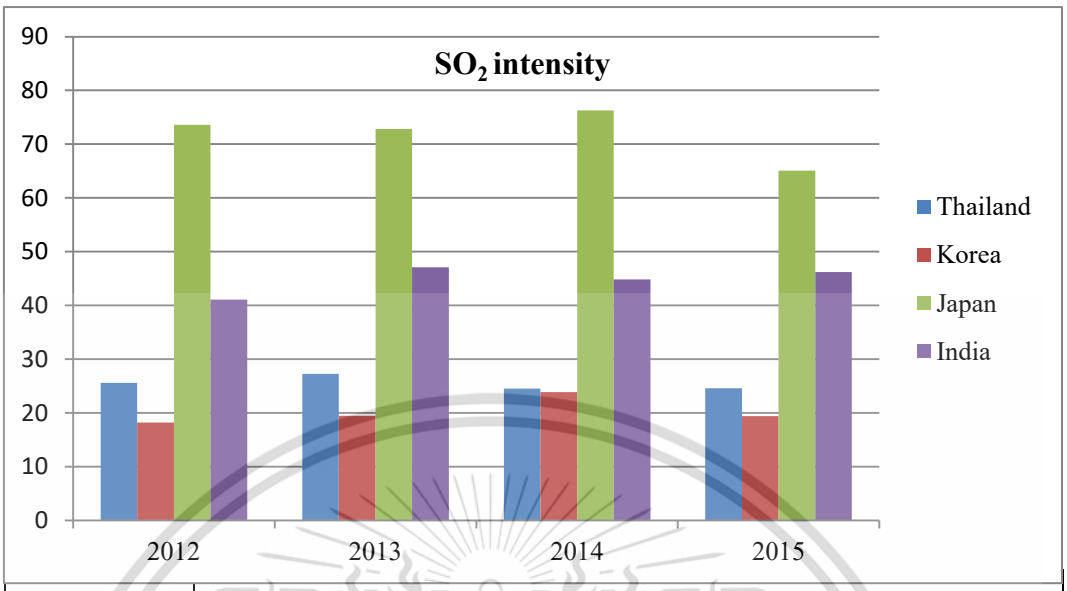
CHAPTER 4

Results and Discussion

4.1 Environmental Performance Evaluation Results

Table 4.1 shows the EPI of SO_2 in Thailand, Japan, India, and South Korea from 2012 to 2015. As presented in Table 4.1, refineries in South Korea and Thailand performed better than the ones in other countries in terms of SO_2 emission level. The table also shows that refineries in South Korea consistently had the lowest SO_2 emission compared to refineries in the other three countries. In 2012, South Korea SO_2 level was 18.195 g/bbl. SO_2 level continued to rise and reached the highest level in 2014 at 23.850 g/bbl. However, in 2015 it was reduced to 19.440 g/bbl. Overall, Japan had the highest SO_2 emission of 76.275 g/bbl in 2014, followed by India, which emitted 47.112 g/bbl in 2013. It should be noted that only Japan SO_2 was slightly decreased by 11.210g/bbl from 2014 to 2015 because the Ministry of the Environment in Japan strictly controlled SO_2 emission not to exceed 0.00004 grams per hour (Environmental quality standards in Japan, 1973).

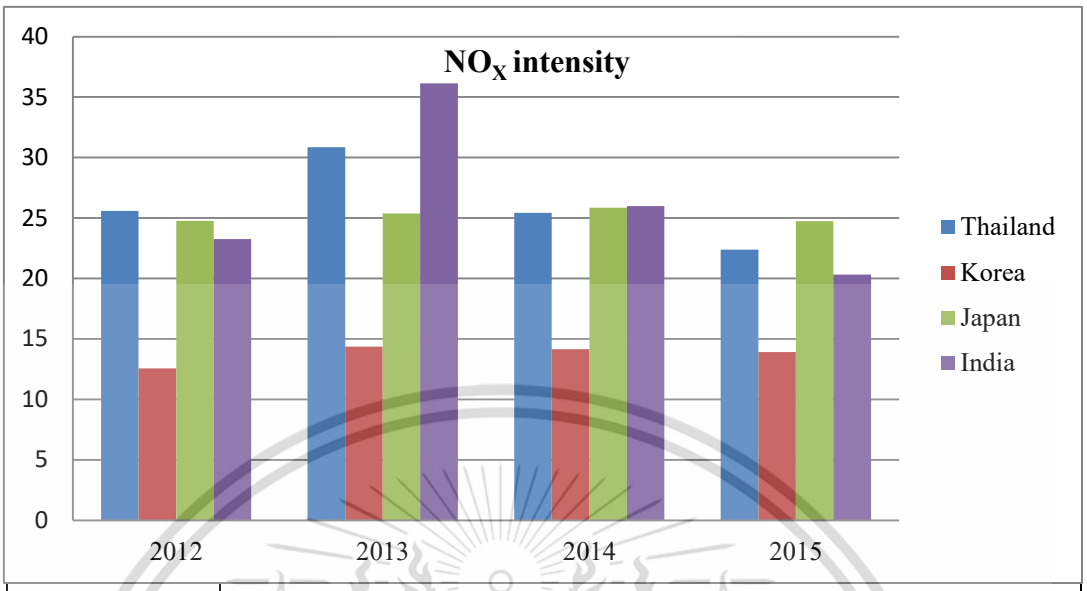
Table 4.1 Environmental Performance Indicator of SO_2



EPIs	SO_2 Intensity (g/bbl)			
	2012	**2013**	**2014**	**2015**
Thailand	23.632	27.244	24.532	24.620
South Korea	18.195	19.490	23.850	19.440
Japan	73.620	72.795	76.275	65.065
India	41.105	47.112	44.810	46.202

Table 4.2 shows EP of the refineries based on NO_x emission. The table shows that South Korea is ranked on top among the four countries with an emission value of only 12.560 g/bbl in 2012. The emission value had gradually increased, but still considered low compared to the other countries. The NO_x emission levels of refineries in India, Thailand, and Japan are somewhat similar during the four-year study period. In 2013 Thailand had an increase in NO_X emission of 5.252 g/bbl and India had an increase of 14.488 g/bbl in regards to 2012. Although in 2013 Thailand and India had a sudden increase, but in 2014 NO_X emission levels were decreased and continued to decrease in 2015. What's noticeable in the table below was that the level of NO_x emission of the four countries had steadily decreased from the year 2012 to 2015.

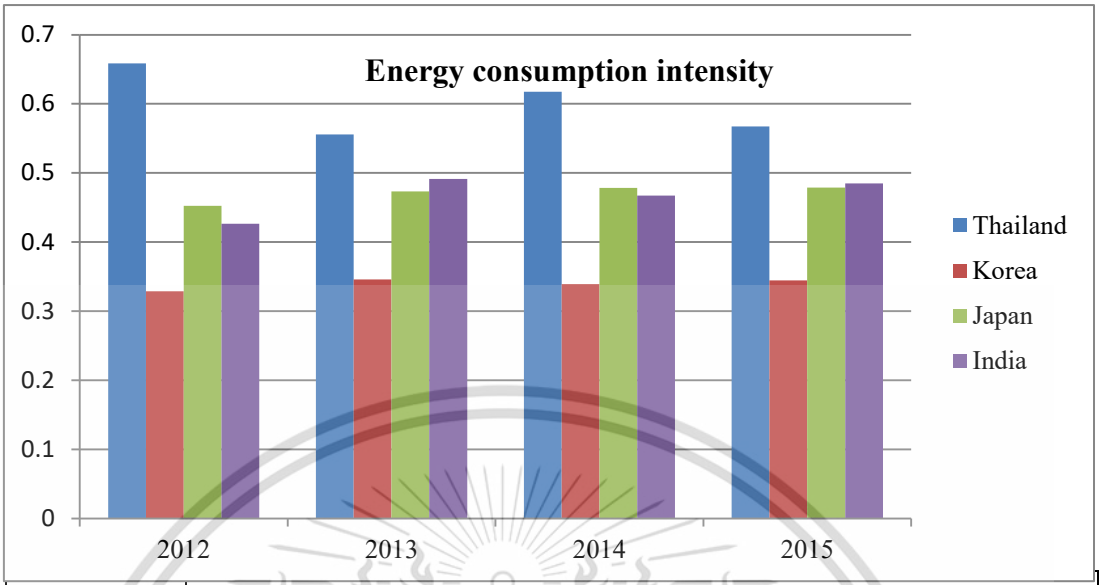
Table 4.2 Environmental Performance Indicator of NO_x



EPIs	NO_x Intensity (g/bbl)			
	2012	**2013**	**2014**	**2015**
Thailand	25.598	30.850	25.422	22.384
South Korea	12.560	14.360	14.160	13.925
Japan	24.780	25.370	25.860	24.750
India	23.257	37.745	26.000	20.320

Table 4.3 presents EP of the studied refineries based on energy consumption. The study period Japan and India energy consumption level is quite similar. In 2015, South Korea performed better in terms of energy consumption with 0.344 gj/bbl, followed by Japan with 0.479 gj/bbl, and India with 0.484 gj/bbl. Thailand had the highest energy consumption with 0.567 gj/bbl. Moreover, it can be seen in the table that the refineries in Thailand had the highest energy consumption value among the other three countries for the entire period from 2012 to 2015.

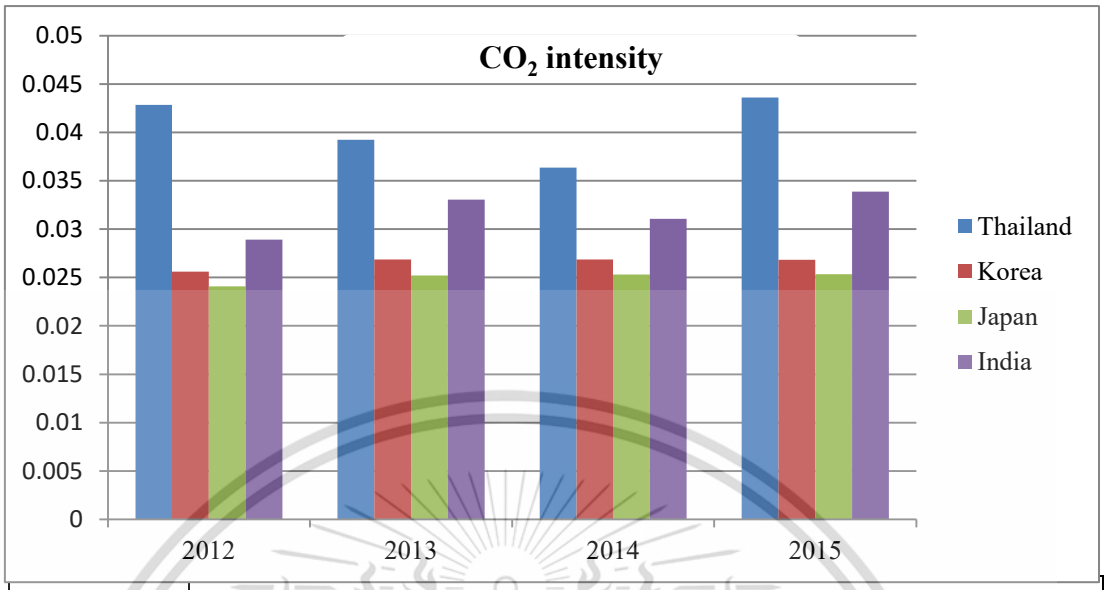
Table 4.3 Environmental Performance Indicator of Energy Consumption



EPIs	Energy Consumption Intensity (gj/bbl)			
	2012	**2013**	**2014**	**2015**
Thailand	0.658	0.555	0.620	0.567
South Korea	0.328	0.345	0.339	0.344
Japan	0.452	0.473	0.478	0.479
India	0.426	0.491	0.467	0.484

The fourth EPI measured was CO_2 emission. As presented in Table 4.4 this indicator yields different results from the other three indicators. Japan appeared to be the best performer with CO_2 value of 0.024 ton/bbl in 2012; the emission level remained somewhat constant in the following years. Overall the second best performer with CO_2 value of 0.025 ton/bbl in 2012 is South Korea. Refineries in South Korea and India had emission values better than Thailand. Thailand refineries performed worst in terms of CO_2 Emission. In 2013 and 2014 Thailand reduced CO_2 Emission in regards to 2012, but in 2015 it increased up to 0.043 ton/bbl.

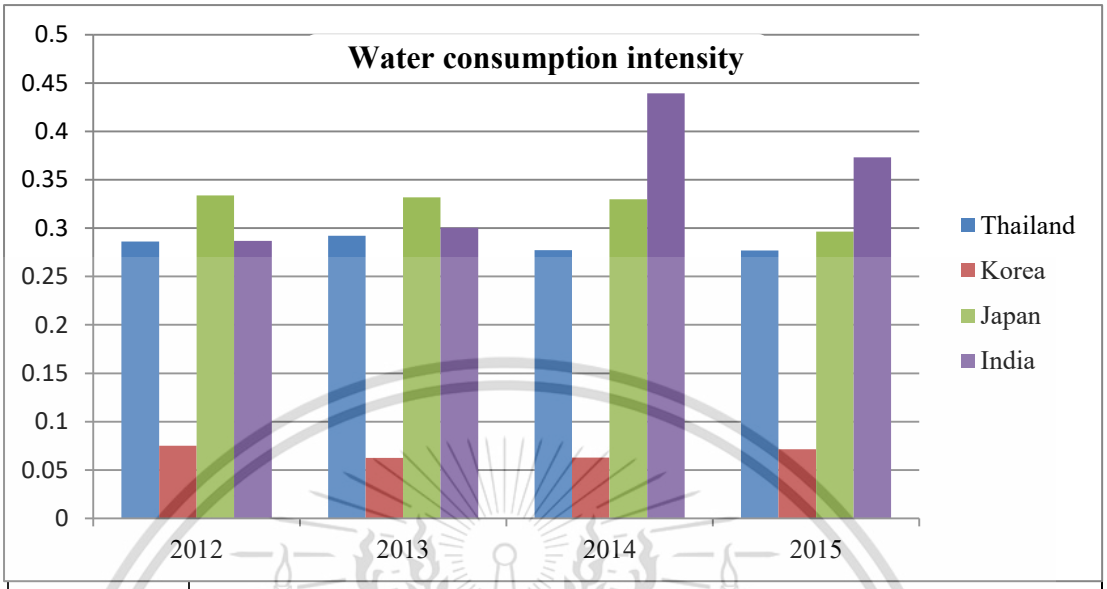
Table 4.4 Environmental Performance Indicator of CO_2 Emission



EPIs	CO_2 Intensity (Ton/bbl)			
	2012	2013	2014	2015
Thailand	0.042	0.039	0.036	0.043
South Korea	0.025	0.026	0.026	0.026
Japan	0.024	0.025	0.025	0.025
India	0.028	0.033	0.031	0.033

Last but not least, the last EPI study of this section is water consumption. As presented in Table 4.5, refineries in South Korea performed best with water consumption level of 0.075 m^3/blue in 2012, which was gradually decreased to 0.071 m3/bbl in 2015. Thailand is the second-best performer with water consumption level 0.286 m^3/bbl in 2012 and 0.276 m^3/bbl in 2015. The refineries of Thailand, Japan and India had a slightly different performance.

Table 4.5 Environmental Performance Indicator of Water Consumption



EPIs	Water Consumption Intensity (m^3/bbl)			
	2012	2013	2014	2015
Thailand	0.286	0.292	0.277	0.276
South Korea	0.075	0.062	0.062	0.071
Japan	0.333	0.331	0.329	0.296
India	0.286	0.300	0.439	0.373

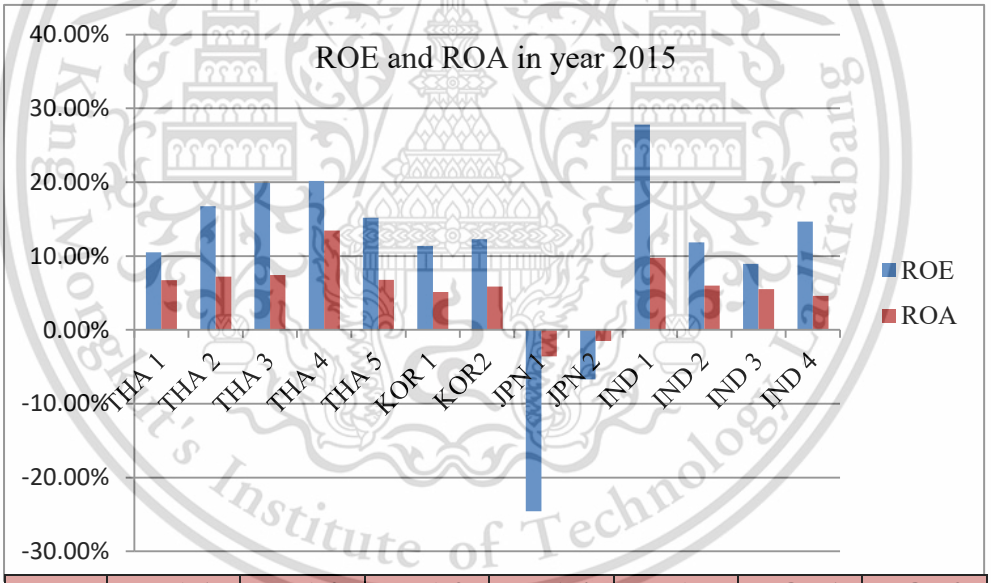
Taking everything into account, it can be seen that each refinery in the four countries performed differently in terms of EP. These variations are probably due to the factors such as technology, social, size, and control systems. In terms of the overall EPIs evaluation, South Korea refineries consistently showed best performance in four indicators: SO_2 emission, NO_x emission, energy consumption and water consumption. This is because of South Korea continues to improve their EP in every year. For instance, in 2012 Ministry of Environment of South Korea cooperate with the US environmental protection agency which aim to start environmental cooperation agreement name “Korea United States Free Trade Agreement”. The Major driver of

this agreement is to establish a framework for improving sustainable management of natural resource and also strengthening of environmental law enforcement. However, Japan ranked better than South Korea in terms of CO_2 emission performance. Overall, This section also shows that refineries in Thailand and India had the lowest EP during 2012 to 2015.

4.2 Business Performance Evaluation Results

The study has chosen ROE and ROA as tools to evaluate the BP. The result of the BP of thirteen oil refineries in four different countries is shown in Table 4.6

Table 4.6 ROE and ROA of 12 Refineries in 4 Countries



BP	THA 1	THA 2	THA 3	THA 4	THA 5	KOR 1	KOR 2
ROE	10.51%	16.74%	19.93%	20.17%	15.19%	11.36%	12.27%
ROA	6.73%	7.23%	7.45%	13.46%	6.76%	5.13%	5.85%
BP	**JPN 1**	**JPN 2**	**IND 1**	**IND 2**	**IND 3**	**IND 4**	
ROE	-24.55%	-6.69%	27.81%	11.87%	8.94%	14.65%	
ROA	-3.56%	-1.50%	9.78%	5.99%	5.54%	4.59%	

The results indicate that ROE of refineries in Thailand, South Korea, and India were profitable with the profit level of 20%, 12%, and 30%, respectively. It is noticeable that refineries in Japan faced a dramatic drop in profit level in 2015, which is probably due to the major earthquake in 2011. The earthquake posed great damage to the country and widely impacted profitability of many companies in Japan (EIA, 2017). In terms of ROA, the results appeared to be different. Refineries in Thailand performed the best, followed by India, South Korea, and Japan. Overall, the BP evaluation results illustrate a contrast results with EP, refineries in India and Thailand perform better in terms of BP.

4.3 Correlation Coefficient between EP and BP Results

The study conducted the correlation coefficient test to find the relationship between EP and BP. EPIs data were plotted against ROE and ROA as presented in Tables 4.7 to 4.11. The results show that SO_2 shows strong negative relationship compared to the other four EPIs, with a correlation value of -0.554 with ROE and -0.417 with ROA, respectively, in 2012. This is probably because of the requirements of European emission standards in the oil refinery. The European emission standard was used to define the fuel quality improvement that wants to improve air quality and health. This standard had six different stages Euro I to Euro VI, which aims to stringent exhaust pollution (Edmund, 2017). For instance, in 2012 Thailand became the first country in Southeast Asia to move in Euro IV fuel standard. This improvement had reduced the country SO_2 emission in around 12,000 million tons per year (Kosit, 2012). These results reflect the fact that all oil refineries had decreased their SO_2 emission levels in compliance with the European Emission standards. However, in 2015, both variables show weak negative relationship with a correlation value of -0.347 with ROE and -0.276 with ROA. This is due to the attempt to increase

the capacity of oil refinery production (Bevilacqua & Braglia, 2002). The results of NO_X, energy consumption, CO_2 and water consumption illustrate that there is a weak relationship with both ROE and ROA with correlation value lower than -0.3 (Cohen, Fenn, & Naimon, 1995). Thereore, it can be recognized that making an investment on the EP is not the only reason for achieving better BP, however intangible assets and external benefits such as the company's reputation and social responsibilities should also be considered as part of the outcome of being a sustainable company. Overall, it can notice that SO_2 in year 2012 is the most effective parameters to ROE and ROA in the year 2015. This means that achieving good EP, solely, may not directly impact BP of refineries. However, many companies still put more efforts on applying environment-friendly. This is because they believe that EP of their business today will generate more revenue and cost saving in the future. For example,

- The customer may be willing to pay and buy more on the green product.
- Environment responsibility can promote the company reputation.
- New technology production with less energy, less raw material and less waste also generate revenue in the company.

Table 4.7 Correlations Coefficient between SO_2 and ROE & ROA

Correlation Coefficient "R "	**SO_2 Intensity**			
	2012	**2013**	**2014**	**2015**
ROE	-0.554	-0.492	-0.556	-0.347
ROA	-0.417	-0.383	-0.449	-0.276

Table 4.8 Correlation Coefficient between NO_x and ROE & ROA

Correlation Coefficient "R "	NO_x Intensity			
	2012	**2013**	**2014**	**2015**
ROE	-0.157	0.018	-0.106	-0.129
ROA	-0.150	0.108	-0.142	-0.095

Table 4.9 Correlation Coefficient between Energy Consumption and ROE & ROA

Correlation Coefficient "R "	Energy Consumption Intensity			
	2012	**2013**	**2014**	**2015**
ROE	0.101	0.005	0.014	-0.006
ROA	0.019	-0.042	-0.017	-0.041

Table 4.10 Correlations Coefficient between CO_2 and ROE & ROA

Correlation Coefficient "R "	CO_2 Intensity			
	2012	**2013**	**2014**	**2015**
ROE	0.154	0.091	0.077	0.103
ROA	0.092	0.056	0.050	0.076

Table 4.11 Correlations Coefficient between Water Consumption and ROE & ROA

Correlation Coefficient "R "	Water Consumption Intensity			
	2012	**2013**	**2014**	**2015**
ROE	-0.262	-0.230	-0.024	-0.103
ROA	-0.265	-0.229	-0.074	-0.131

CHAPTER 5

Conclusions and Recommendations

5.1 Conclusions

This study mainly researched on the impact of the EP to BP of the oil refinery business in AEC+6 which consists of three main parts. First, the EPIs evaluation of the thirteen oil refineries, which based on the five parameters including sulphur dioxide (SO_2), nitrogen oxide (NO_X), carbon dioxide (CO_2), energy consumption, and water consumption. The results indicate that refineries in South Korea had the highest EP. Refineries and Japan performed most unsatisfactory in terms of CO_2 emission. Refineries in India and Thailand also showed poor performance in all EPIs. Second, the BP was evaluated based on two parameters, ROE and ROA. The results of the BP showed contrast with EP, refineries in India and Thailand perform better in terms of BP. It should be noted, however, that BP of the refinery in Japan dramatically dropped in 2015 due to the impact of earthquake eruption in 2011 (EIA, 2017). Eventually, an analysis to find the relationship between EP and BP of oil refineries in AEC+6 countries during the period of 2012 to 2015 has been done. The study on the correlation coefficient between EP and BP illustrates the weak relationship except for SO_2 emission in 2012, which shows a strong negative relationship. This is because of oil refinery has to put more efforts in their business to reduce the SO_2 emission, which aim to reach the requirement of European emission standard. Moreover, the result of the study also indicated that obtain a better EP in the current period may affect the cost and revenue in the future. When companies invest in the green production process, frequently these new technologies will increase the expenses including systematic cost and training cost. However, this new environmentally friendly

production process can reduce the energy consumption, generate less waste, and less output emission. Future more, today customers and investors also willing to invest and buy more of the environmentally friendly products. Overall, It can be seen that adopting the EP can expand the expense in the current period. However, it will generate benefits in both financial and nonfinancial perspectives for company in the future.

5.2 Recommendations

The results also suggest that improving EP may not lead to achieving better BP. However, refineries should still consider environmental and social aspects to improve its EP to be a sustainable company. Company's reputation in sustainability deems as intangible assets, which have become more and more important nowadays. Therefore, this study encourages all businesses should adopt sustainability best practices. Because of sustainability best practices can enhance the company reputation and brand value by promoting consumer loyalty. Moreover, applying sustainability best practices can also benefit in financial savings. For instance,

- Reducing energy consumption can save the expense of the companies
- Reducing and reusing raw materials can save the company's costs and decrease the waste of production
- Reducing the water expense in the companies
- Recycling resource can save disposal costs

Lastly, due to the limitation of data collection, it is suggested that future studies should consider looking into various environment project data and financial data that may affect EP and BP. Moreover, this study had utilized data from a short period of time, from the year 2012 to 2015. Due to the short period of time, data analysis might have been affected by social issues and economic crisis, which cannot

be predicted. Therefore, in the future, further study is recommended to investigate the phenomenon in a longer period of time, expanding the scope of the study thus yielding a more accurate result. Finally, this study recommended that oil refineries should put a priority on improving their sustainability index to show their commitment to environmental protection and societal responsiveness as a whole.

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APPENDIX A

Environmental Performance Indicator results of thirteen oil refineries in four countries

Table A Environmental Performance Indicator of SO_2 emission

Gram/bbl	SO_2 Intensity			
	2012	2013	2014	2015
THA 1	18.69	14.3	11.81	11.05
THA 2	19.17	22.86	20.65	20.3
THA 3	34.91	40.18	36.82	37.03
THA 4	54.52	54.26	52.96	53.72
THA 5	0.87	4.62	0.42	1.001
KOR 1	22.81	24.51	30.5	21.24
KOR2	13.58	14.47	17.2	17.64
JPN 1	110.08	108.25	110.1	91.84
JPN 2	37.16	37.34	42.45	38.29
IND 1	49.46	57.54	51.95	68.75
IND 2	16.98	24.39	20.54	16.38
IND 3	37.83	41.34	43.05	34.18
IND 4	60.15	65.18	63.7	65.5

Table B Environmental Performance Indicator of NO_X emission

Gram/bbl	NO_X Intensity			
	2012	2013	2014	2015
THA 1	45.52	43.14	44.08	43.66
THA 2	38.77	56.8	39	24.21
THA 3	19.59	29.18	21.61	20.57
THA 4	15.65	13.38	14.11	15.65
THA 5	8.46	11.75	8.31	7.83
KOR 1	10.93	13.72	14.32	14.00
KOR2	14.19	15.00	14.00	13.85
JPN 1	17.65	17.36	17.66	14.73
JPN 2	31.91	33.38	34.06	34.77
IND 1	5.36	8.17	10.9	12.77
IND 2	45.13	59.81	54.52	51.71
IND 3	20.01	23	14.35	12.98
IND 4	22.53	60	24.23	3.82

Table C Environmental Performance Indicator of Energy consumption

gj/bbl	Energy consumption Intensity			
	2012	2013	2014	2015
THA 1	1.165	1.170	1.410	1.350
THA 2	0.732	0.704	0.745	0.742
THA 3	0.730	0.288	0.413	0.140
THA 4	0.293	0.295	0.294	0.290
THA 5	0.372	0.322	0.240	0.314
KOR 1	0.309	0.325	0.348	0.326
KOR2	0.349	0.367	0.331	0.363
JPN 1	0.158	0.155	0.158	0.132
JPN 2	0.747	0.791	0.799	0.826
IND 1	0.256	0.293	0.290	0.312
IND 2	0.677	0.870	0.810	0.787
IND 3	0.291	0.330	0.315	0.324
IND 4	0.483	0.474	0.455	0.517

Table D Environmental Performance Indicator of CO_2

Ton/bbl	CO_2 Intensity			
	2012	2013	2014	2015
THA 1	0.081	0.086	0.076	0.104
THA 2	0.053	0.051	0.050	0.051
THA 3	0.038	0.020	0.020	0.019
THA 4	0.018	0.019	0.021	0.020
THA 5	0.024	0.020	0.015	0.023
KOR 1	0.022	0.024	0.026	0.025
KOR2	0.029	0.030	0.028	0.029
JPN 1	0.009	0.009	0.009	0.007
JPN 2	0.039	0.042	0.042	0.043
IND 1	0.017	0.020	0.018	0.023
IND 2	0.043	0.059	0.055	0.052
IND 3	0.024	0.022	0.023	0.023
IND 4	0.031	0.031	0.028	0.037

Table E Environmental Performance Indicator of Water consumption

m^3/bbl	Water consumption Intensity			
	2012	2013	2014	2015
THA 1	0.482	0.569	0.519	0.540
THA 2	0.628	0.615	0.599	0.584
THA 3	0.207	0.179	0.171	0.156
THA 4	0.041	0.038	0.047	0.045
THA 5	0.072	0.059	0.049	0.059
KOR 1	0.065	0.031	0.036	0.037
KOR2	0.085	0.094	0.090	0.106
JPN 1	0.339	0.312	0.305	0.230
JPN 2	0.328	0.352	0.355	0.363
IND 1	0.156	0.191	0.580	0.292
IND 2	0.205	0.281	0.280	0.283
IND 3	0.595	0.567	0.700	0.719
IND 4	0.191	0.163	0.196	0.198

APPENDIX B

Figure A: Relationship between SO_2 intensity in year 2012 and ROE in year 2015

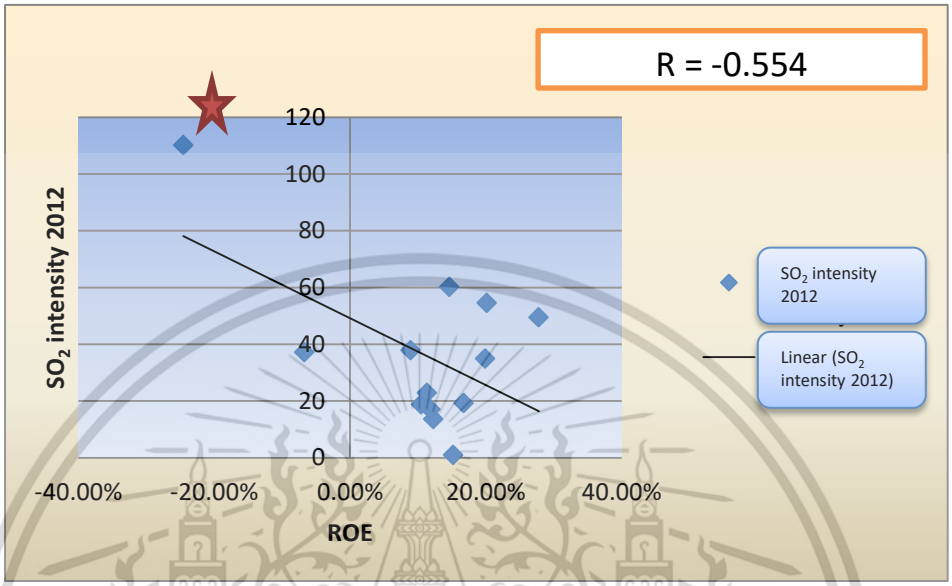
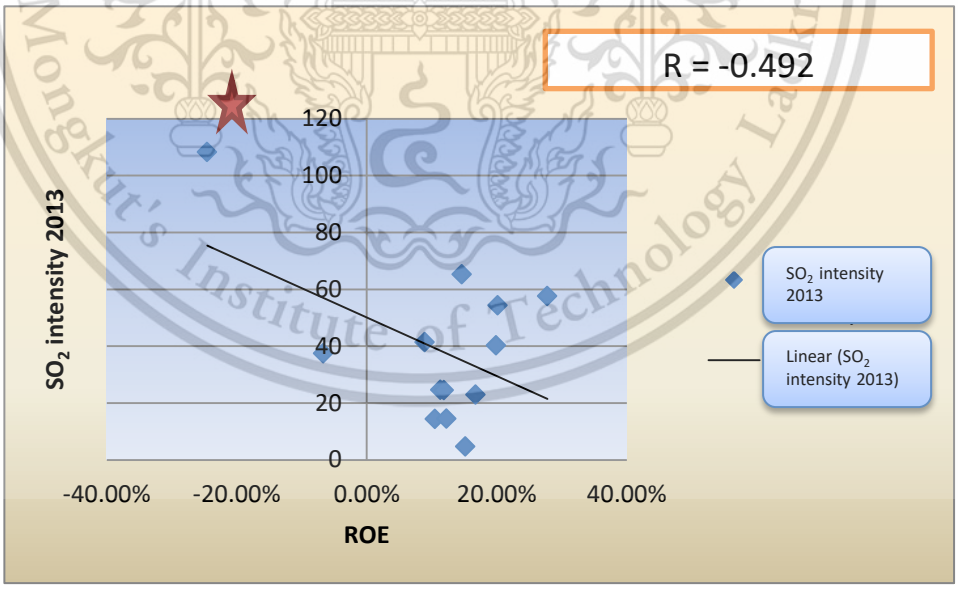


Figure B: Relationship between SO_2 intensity in year 2013 and ROE in year 2015



Noted: Due to limitation of data collection, this data point was Calculated from production capacity in the refinery only.

Figure C: Relationship between SO_2 intensity in year 2014 and ROE in year 2015

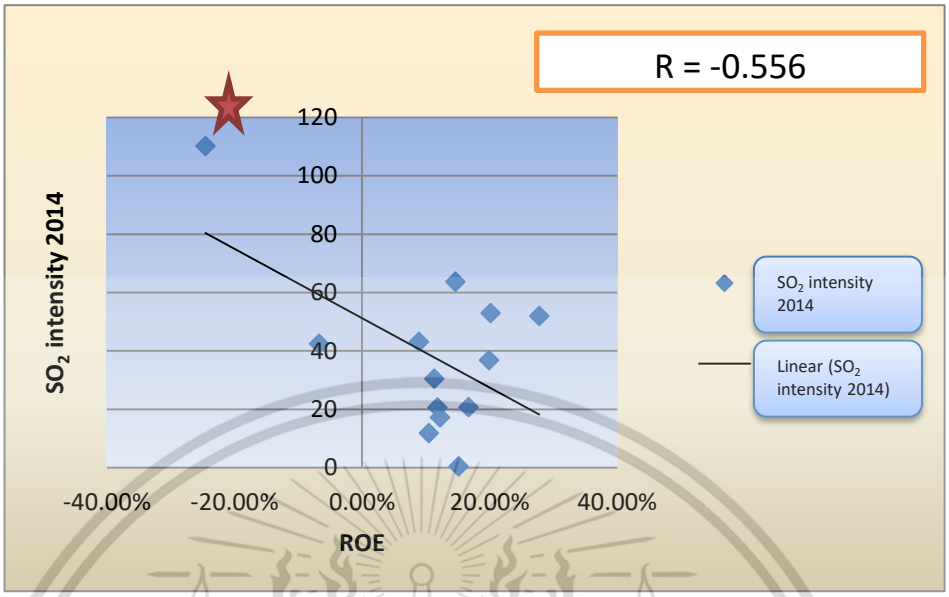


Figure D: Relationship between SO_2 intensity in year 2015 and ROE in year 2015

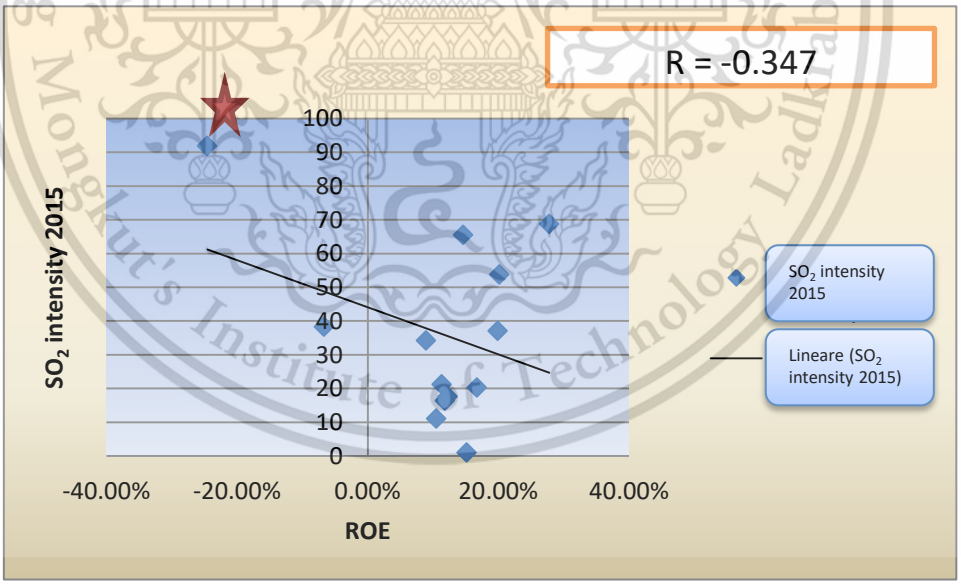


Figure A1: Relationship between SO_2 intensity in year 2012 and ROA in year 2015

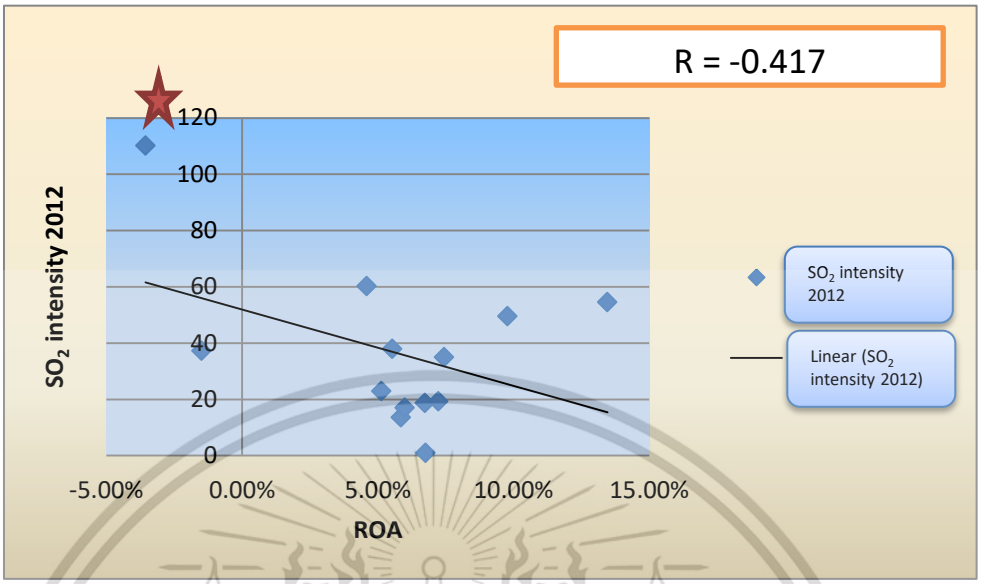


Figure B1: Relationship between SO_2 intensity in year 2013 and ROA in year 2015

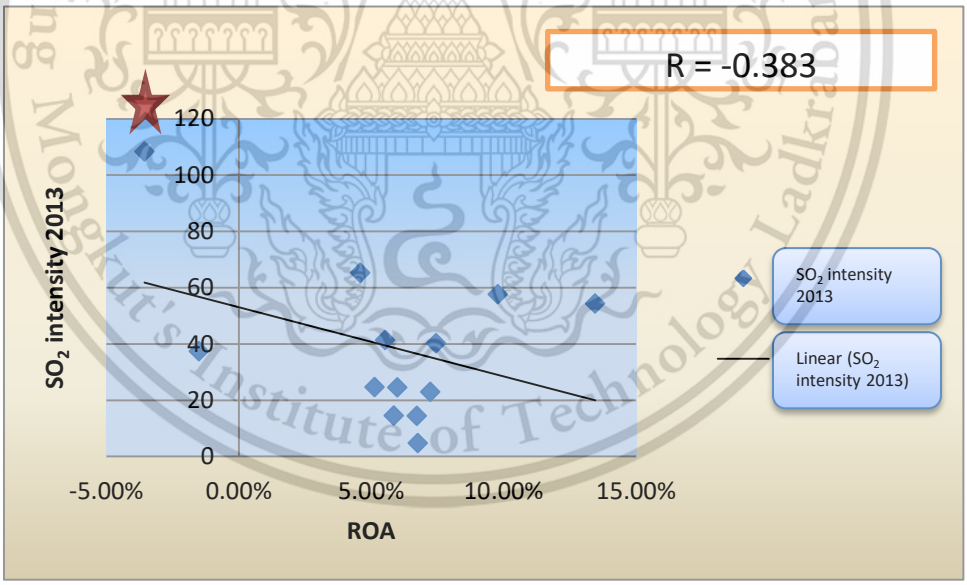


Figure C1: Relationship between SO_2 intensity in year 2014 and ROA in year 2015

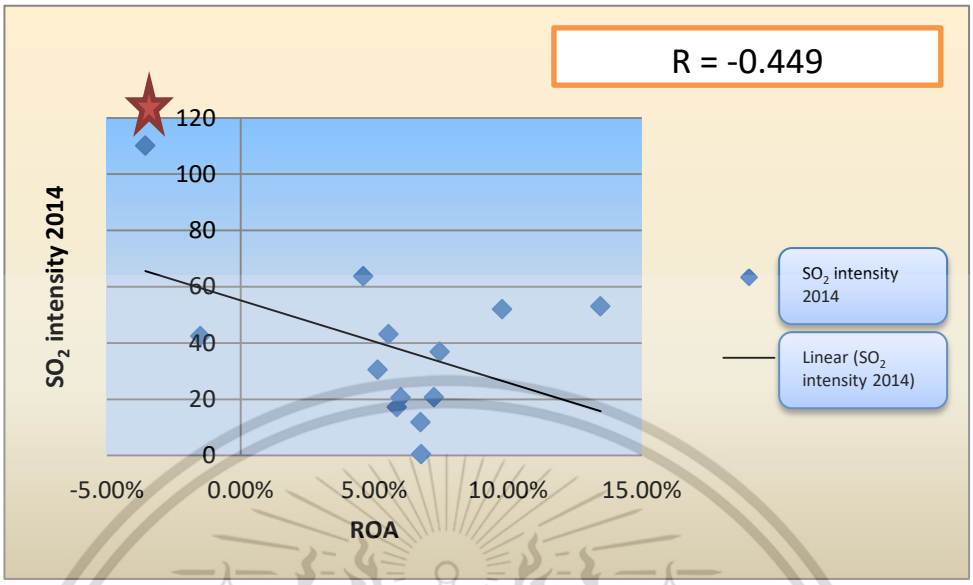


Figure D1: Relationship between SO_2 intensity in year 2015 and ROA in year 2015

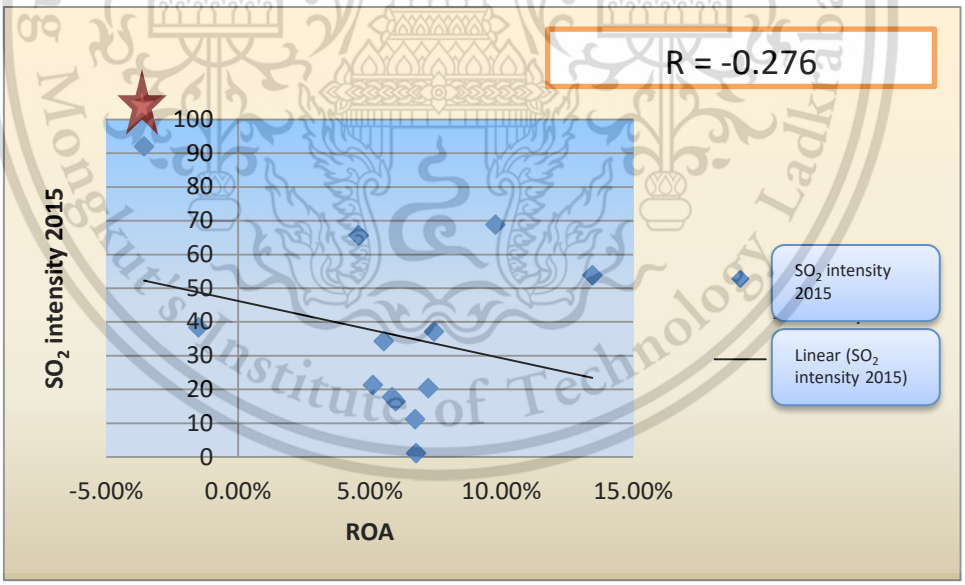


Figure E: Relationship between NO_X intensity in year 2012 and ROE in year 2015

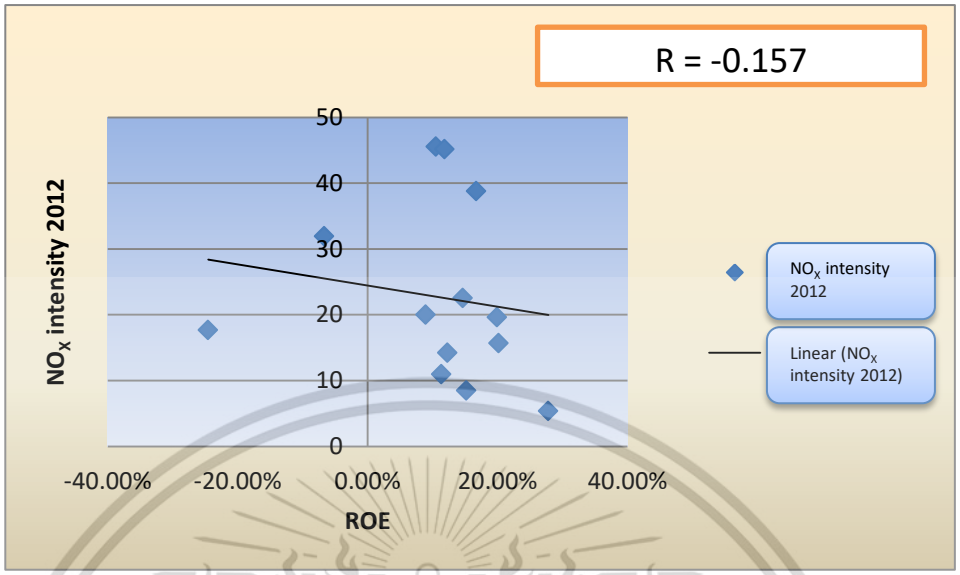


Figure F: Relationship between NO_X intensity in year 2013 and ROE in year 2015

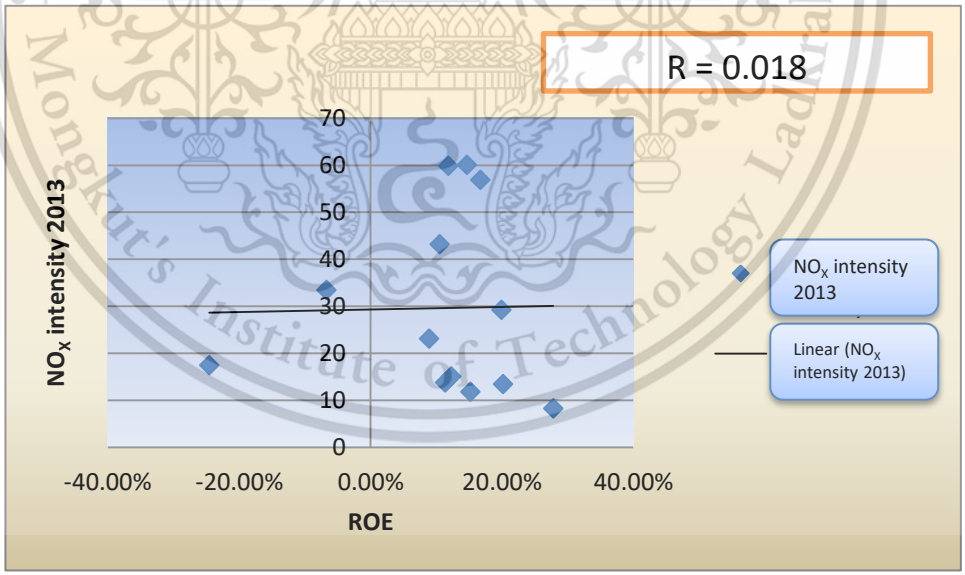


Figure G: Relationship between NO_X intensity in year 2014 and ROE in year 2015

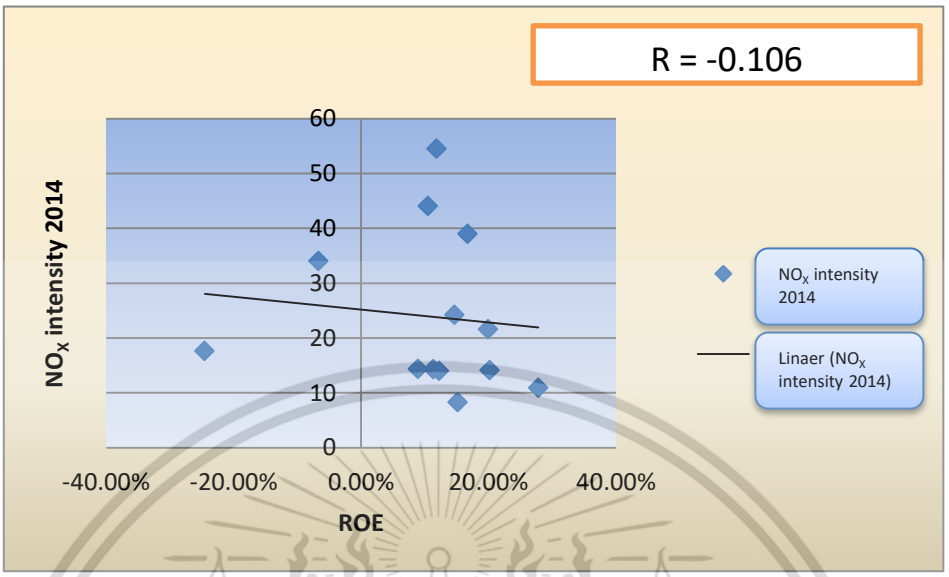


Figure H: Relationship between NO_X intensity in year 2015 and ROE in year 2015

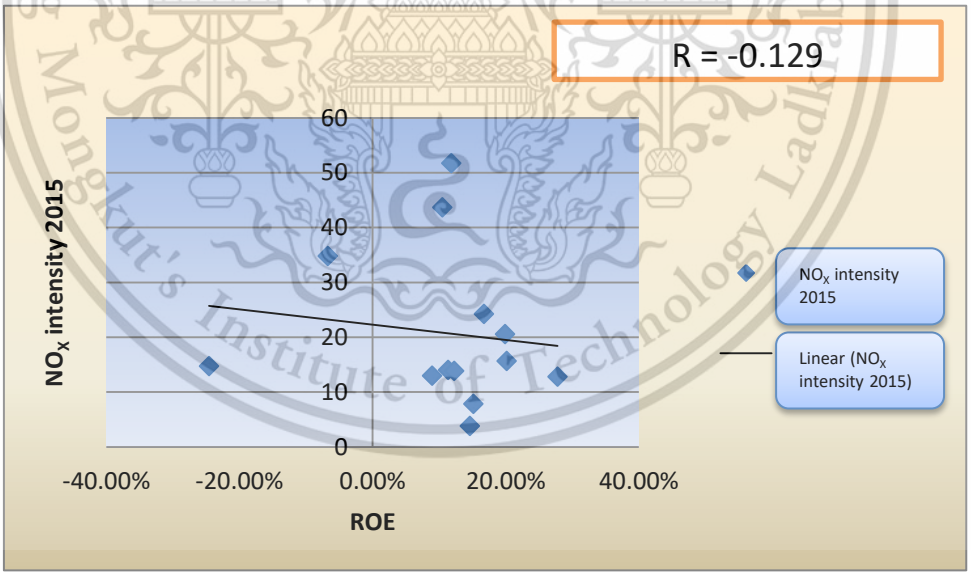


Figure E1: Relationship between NO_X intensity in year 2012 and ROA in year 2015

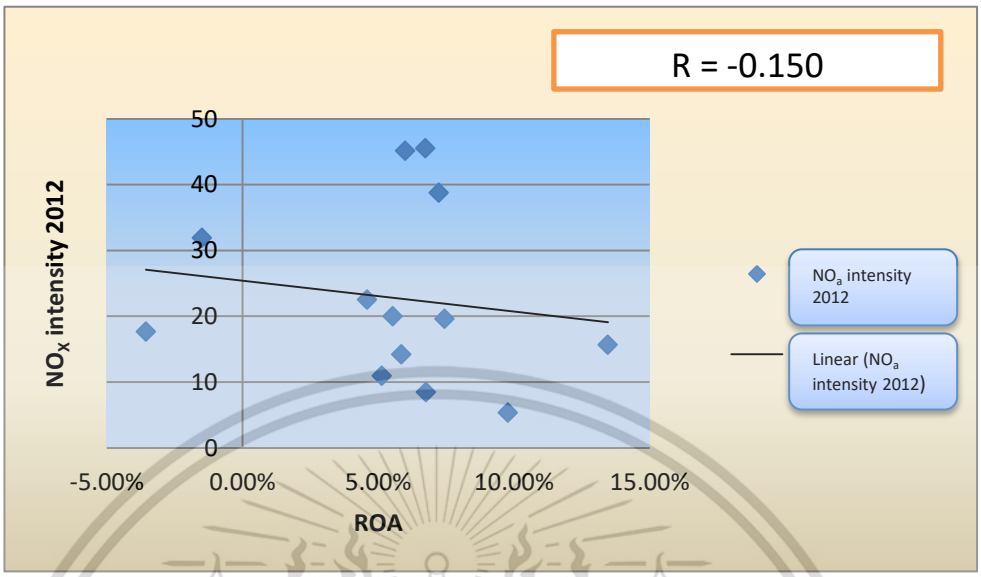


Figure F1: Relationship between NO_X intensity in year 2013 and ROA in year 2015

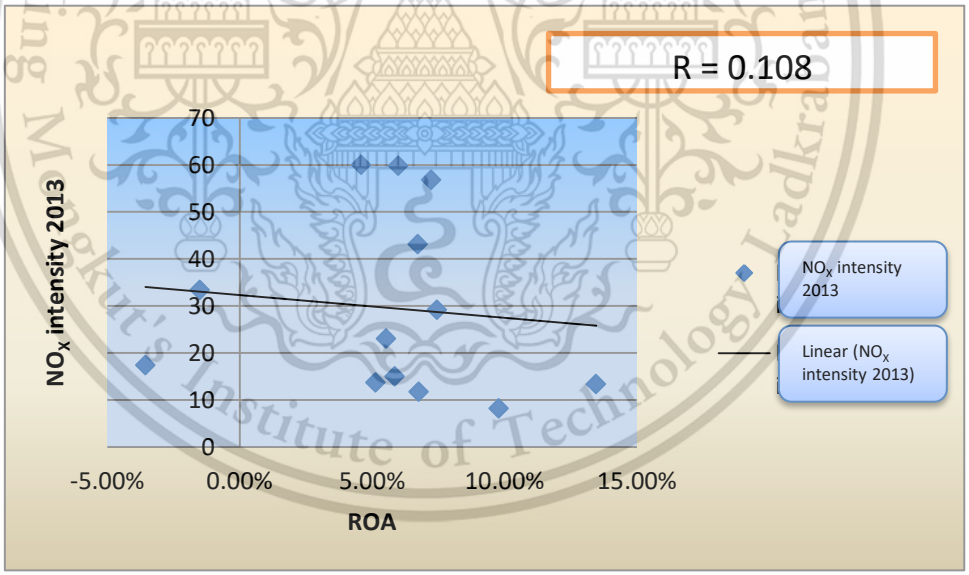


Figure G1: Relationship between NO_X intensity in year 2014 and ROA in year 2015

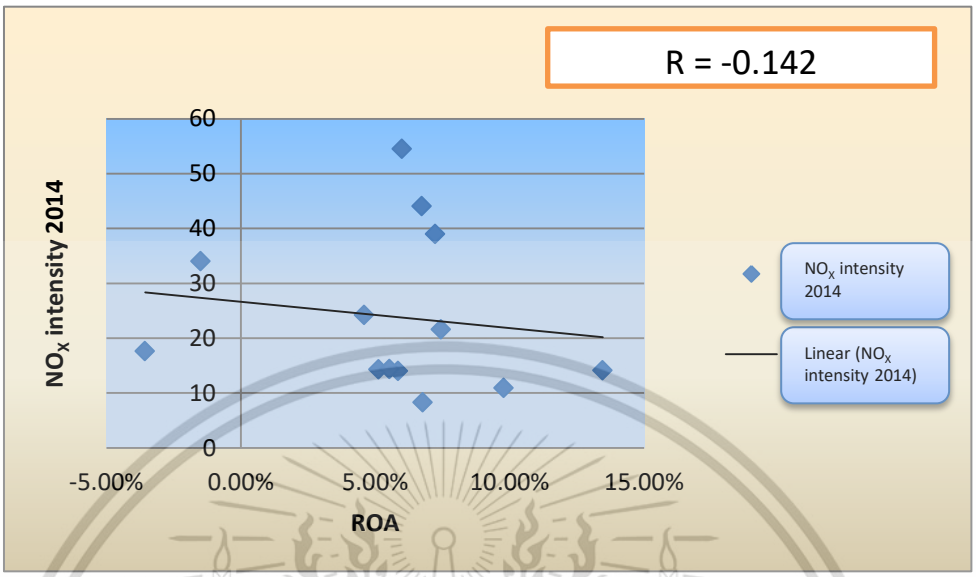


Figure H1: Relationship between NO_X intensity in year 2015 and ROA in year 2015

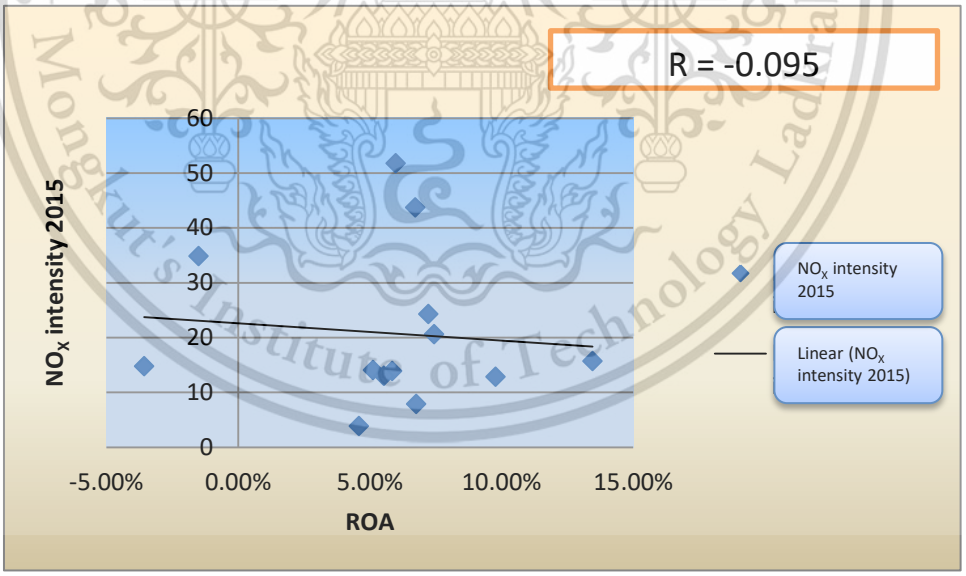


Figure I: Relationship between Energy Consumption intensity in year 2012 and ROE in year 2015

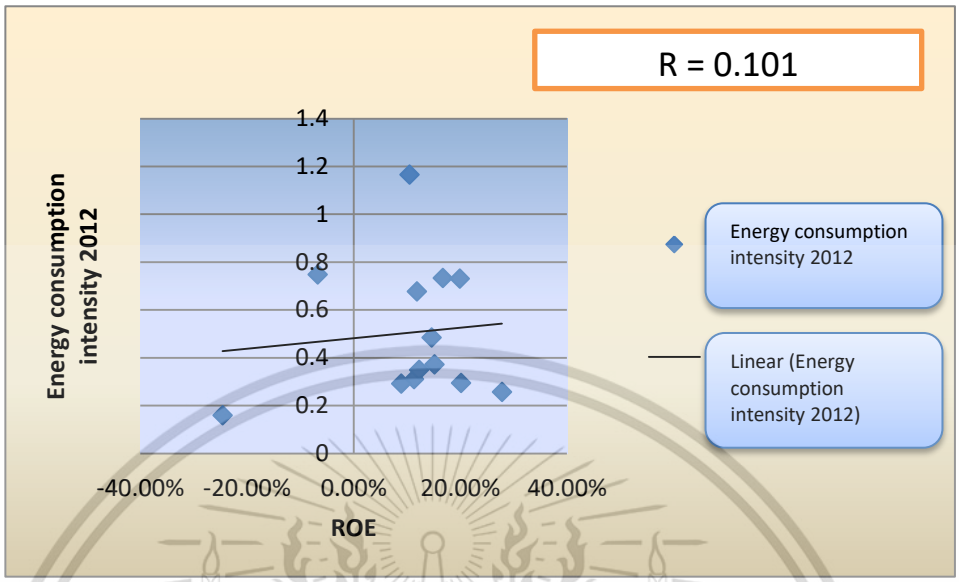


Figure J: Relationship between Energy Consumption intensity in year 2013 and ROE in year 2015

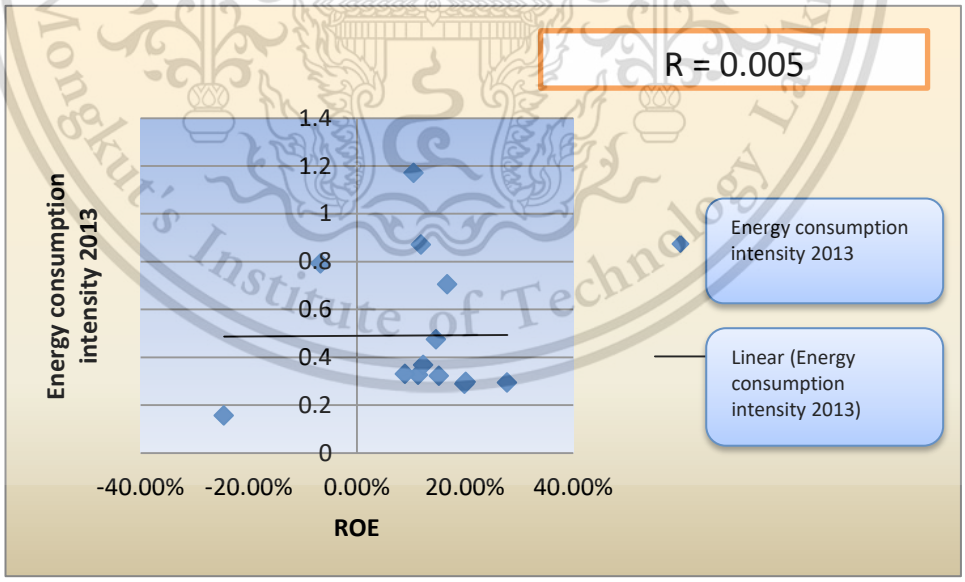


Figure K: Relationship between Energy Consumption intensity in year 2014 and ROE in year 2015

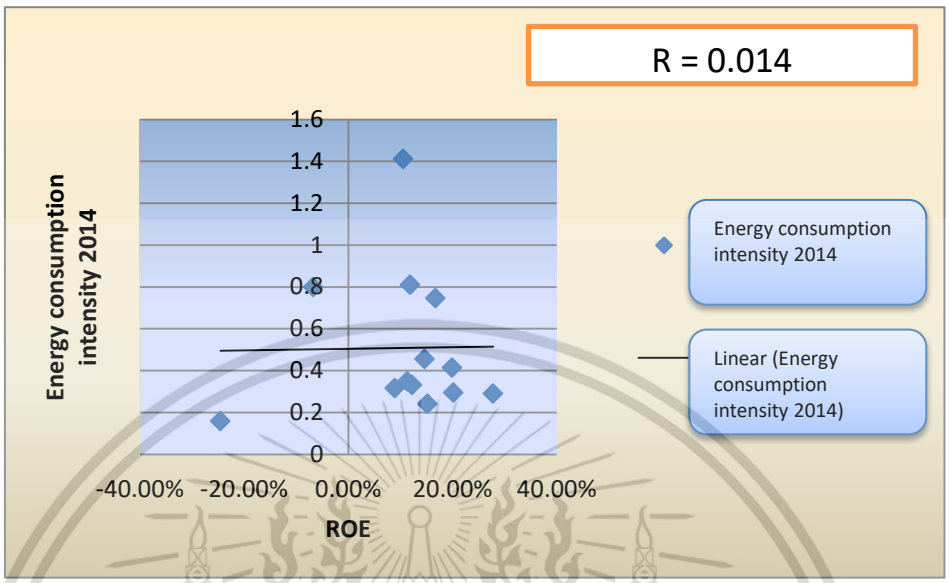


Figure L: Relationship between Energy Consumption intensity in year 2015 and ROE in year 2015

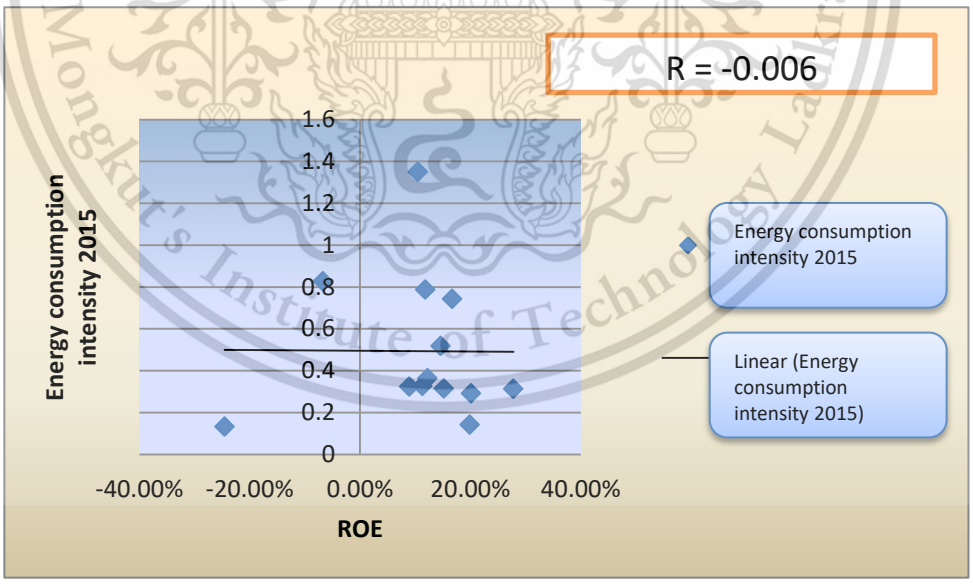


Figure I1: Relationship between Energy Consumption intensity in year 2012 and ROA in year 2015

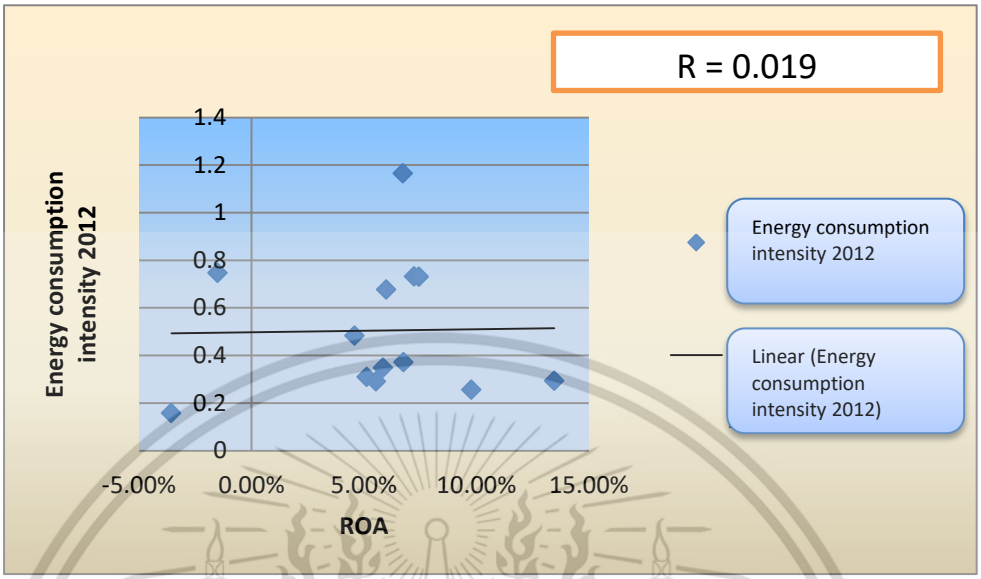


Figure J1: Relationship between Energy Consumption intensity in year 2013 and ROA in year 2015

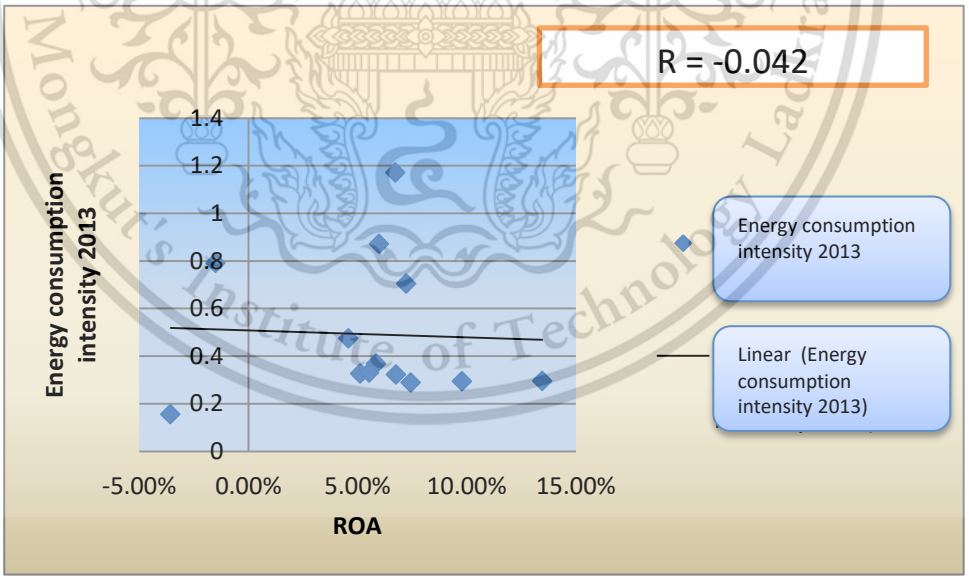


Figure K1: Relationship between Energy Consumption intensity in year 2014 and ROA in year 2015

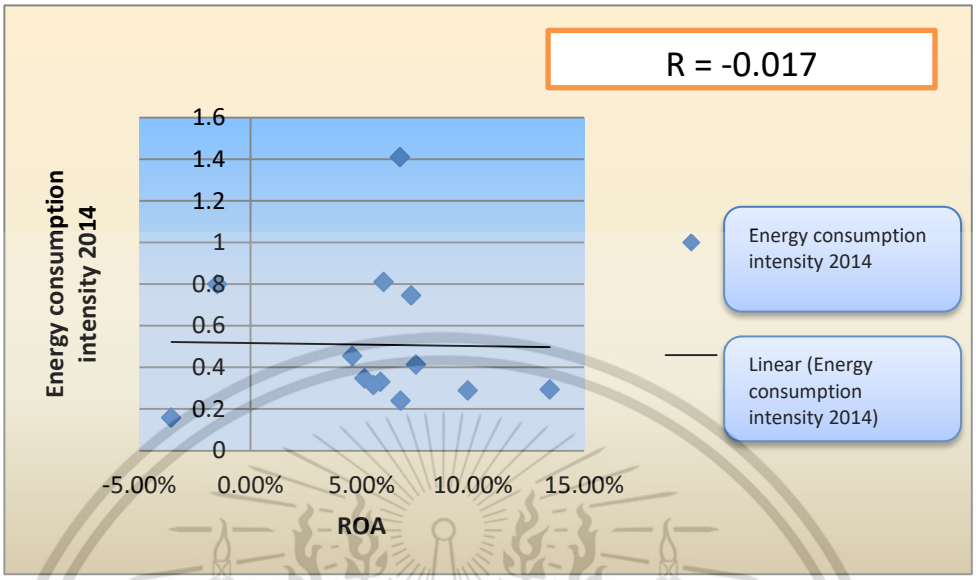


Figure L1: Relationship between Energy Consumption intensity in year 2015 and ROA in year 2015

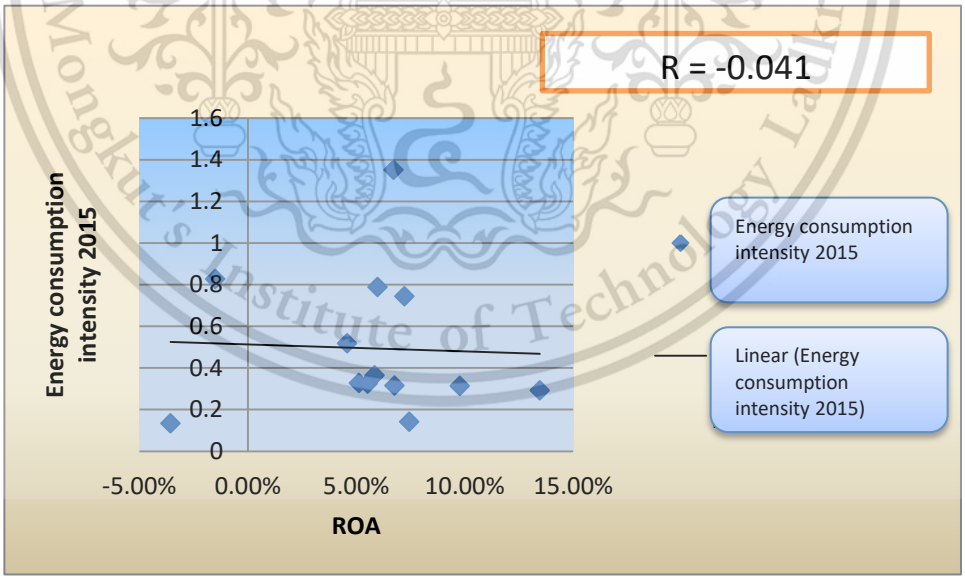


Figure M: Relationship between CO_2 intensity in year 2012 and ROE in year 2015

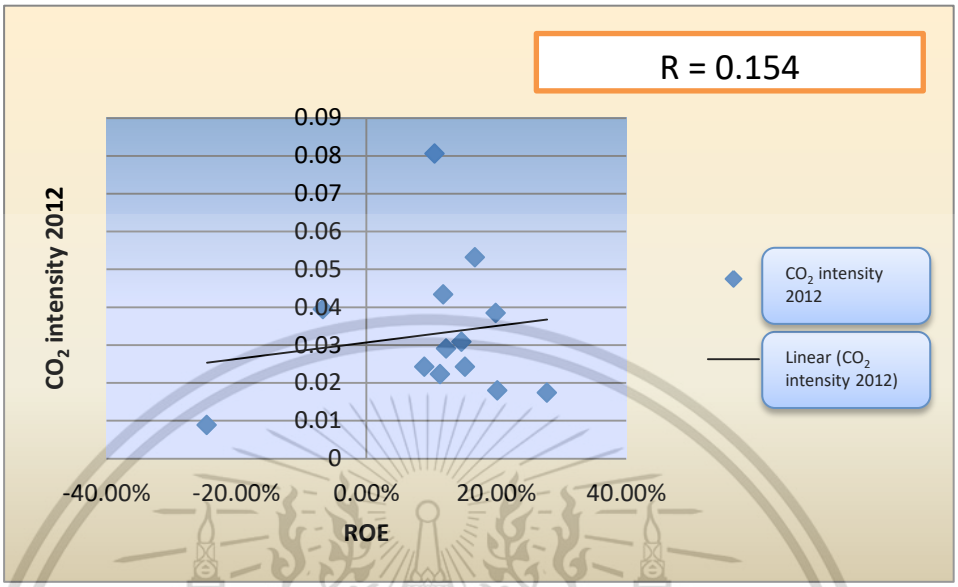


Figure N: Relationship between CO_2 intensity in year 2013 and ROE in year 2015

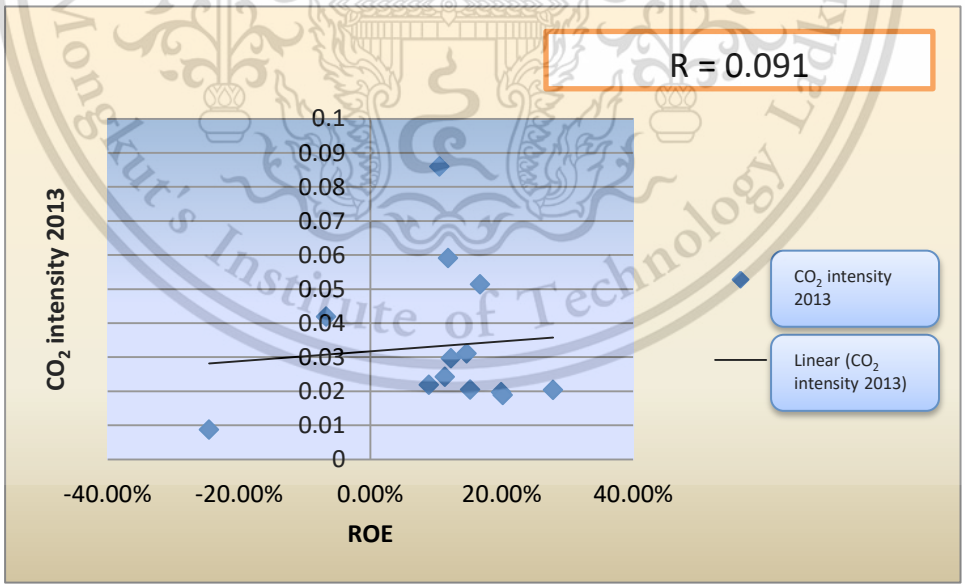


Figure O: Relationship between CO_2 intensity in year 2014 and ROE in year 2015

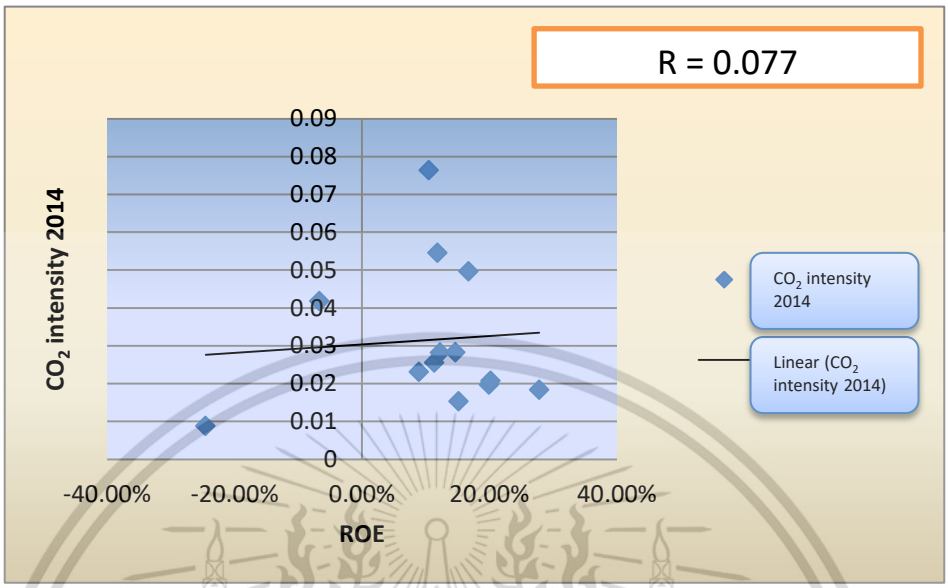


Figure P: Relationship between CO_2 intensity in year 2015 and ROE in year 2015

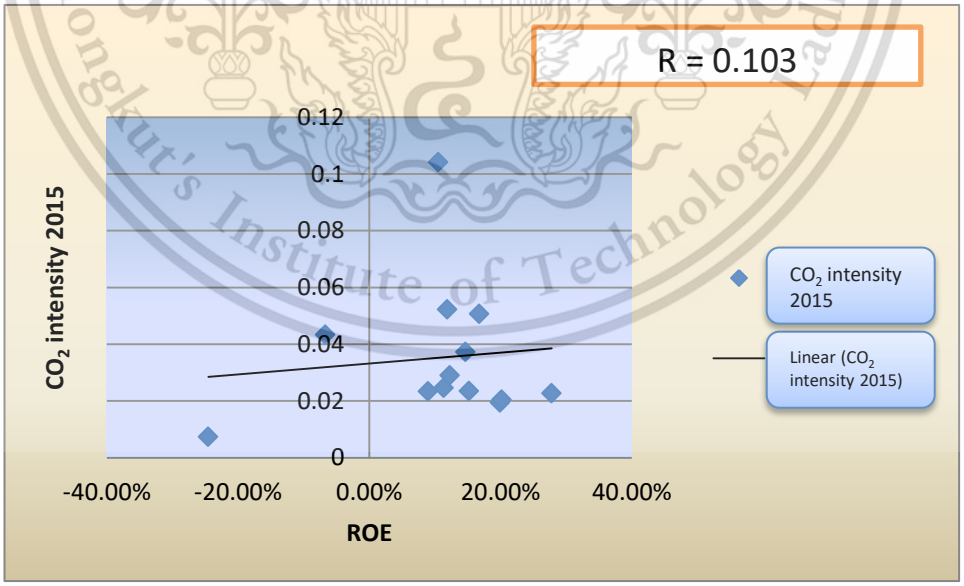


Figure M1: Relationship between CO_2 intensity in year 2012 and ROA in year 2015

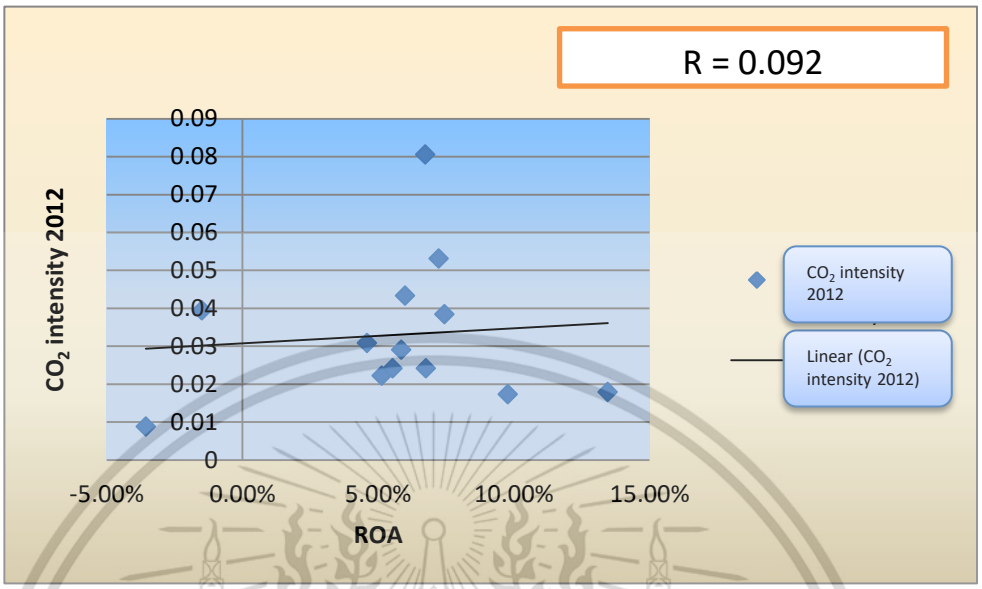


Figure N1: Relationship between CO_2 intensity in year 2013 and ROA in year 2015

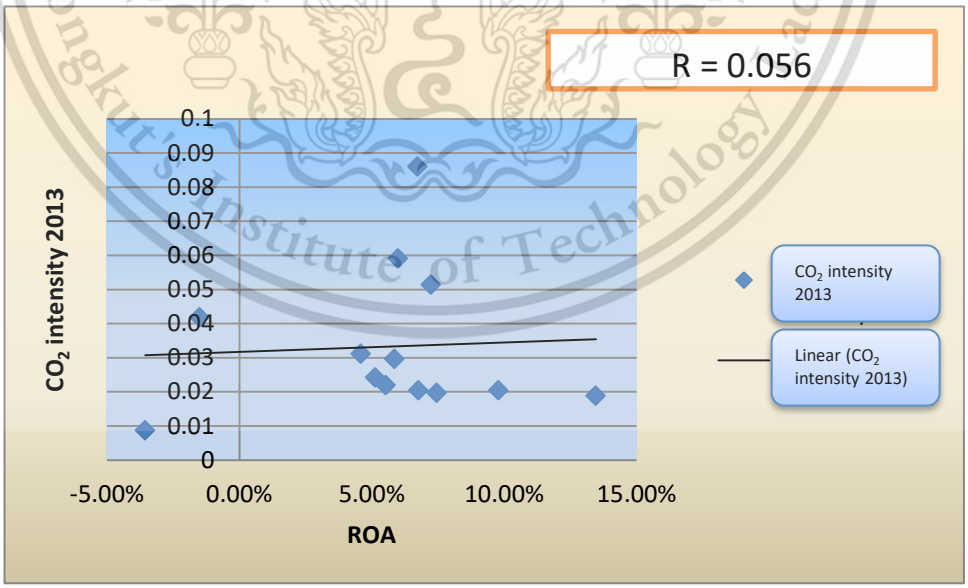


Figure O1: Relationship between CO_2 intensity in year 2014 and ROA in year 2015

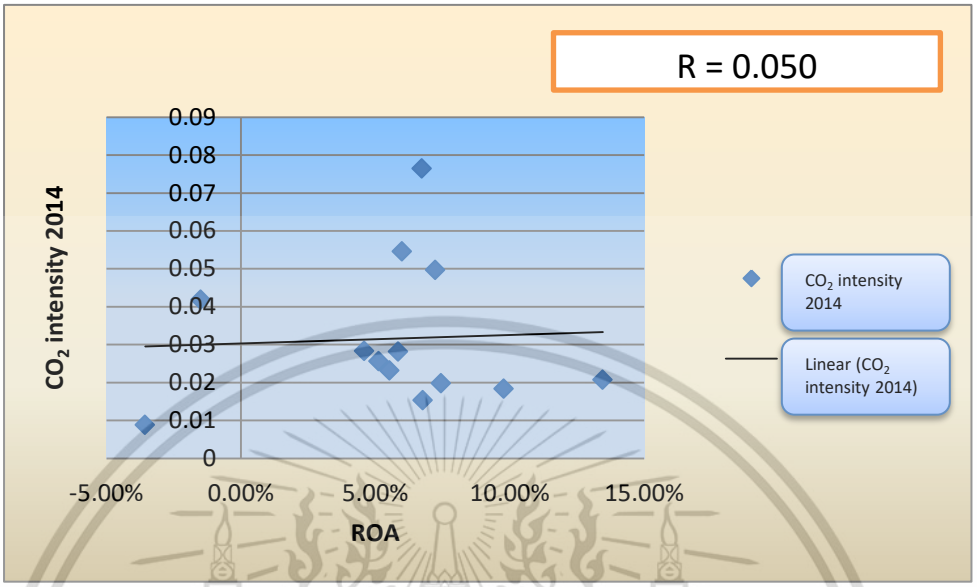


Figure P1: Relationship between CO_2 intensity in year 2015 and ROA in year 2015

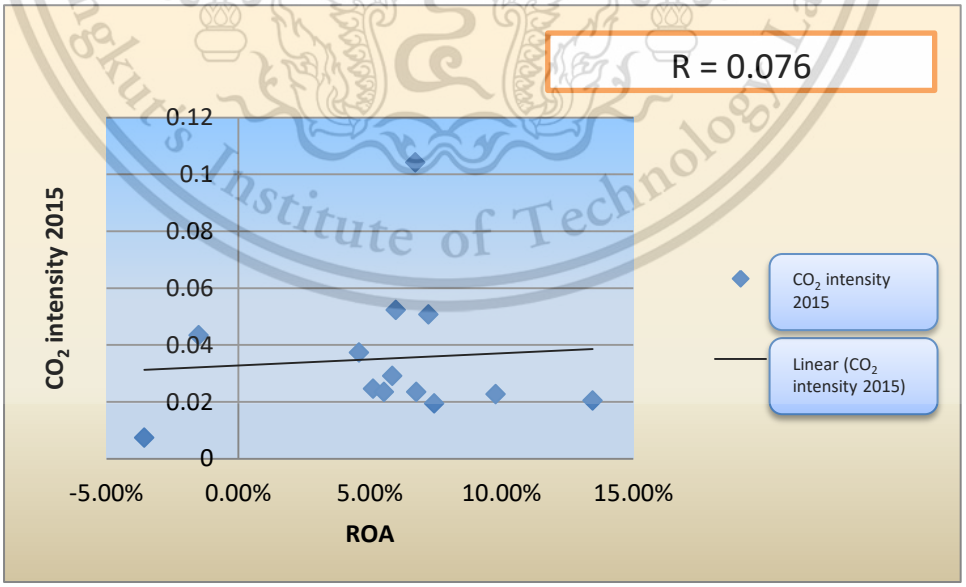


Figure Q: Relationship between Water consumption intensity in year 2012 and ROE in year 2015

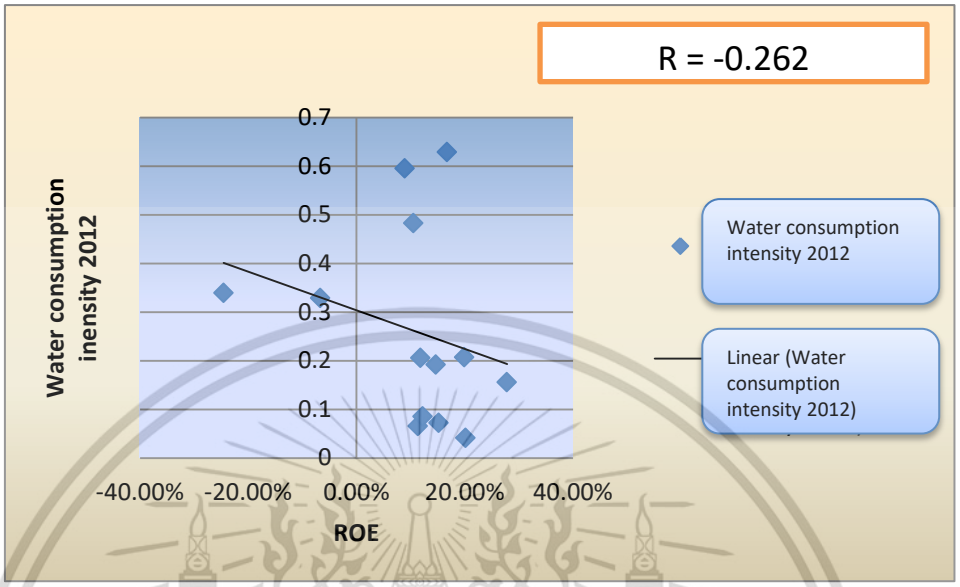


Figure R: Relationship between Water consumption intensity in year 2013 and ROE in year 2015

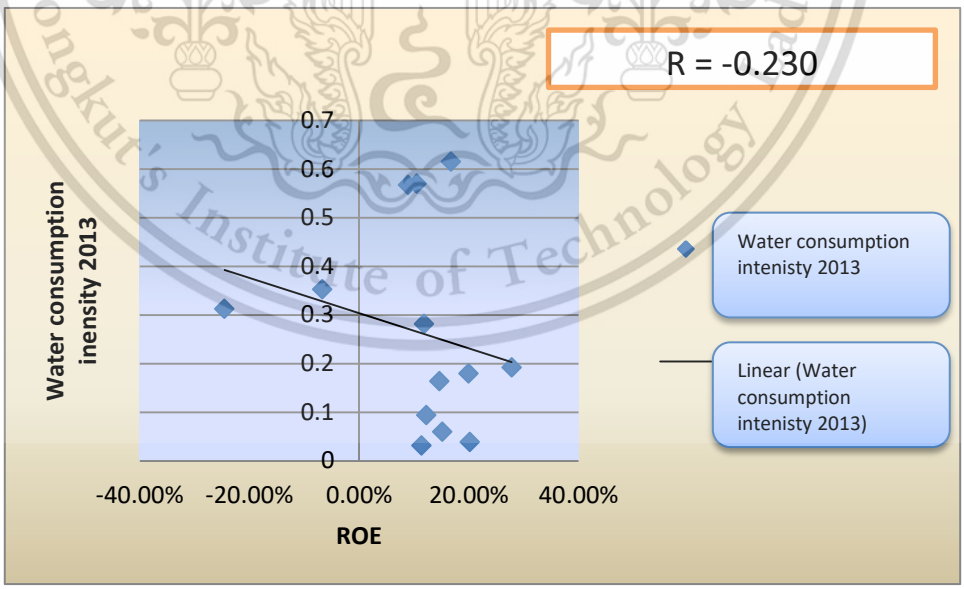


Figure S: Relationship between Water consumption intensity in year 2014 and ROE in year 2015

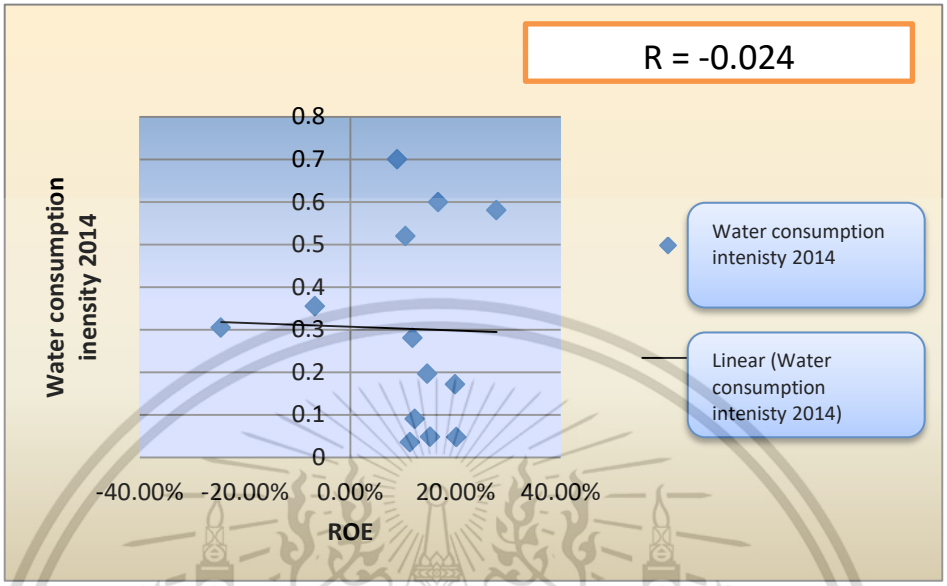


Figure T: Relationship between Water consumption intensity in year 2015 and ROE in year 2015

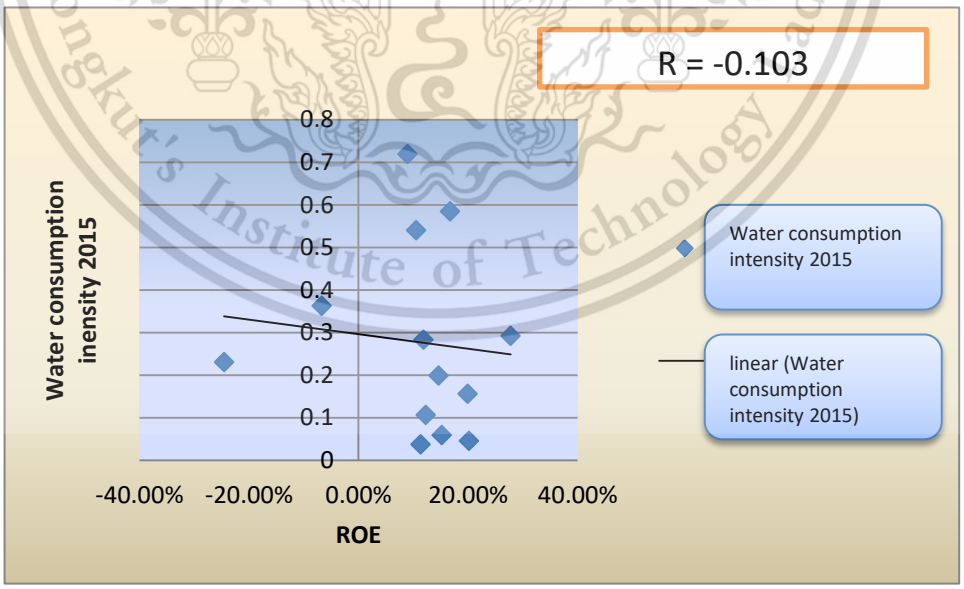


Figure Q1: Relationship between Water consumption intensity in year 2012 and ROA in year 2015

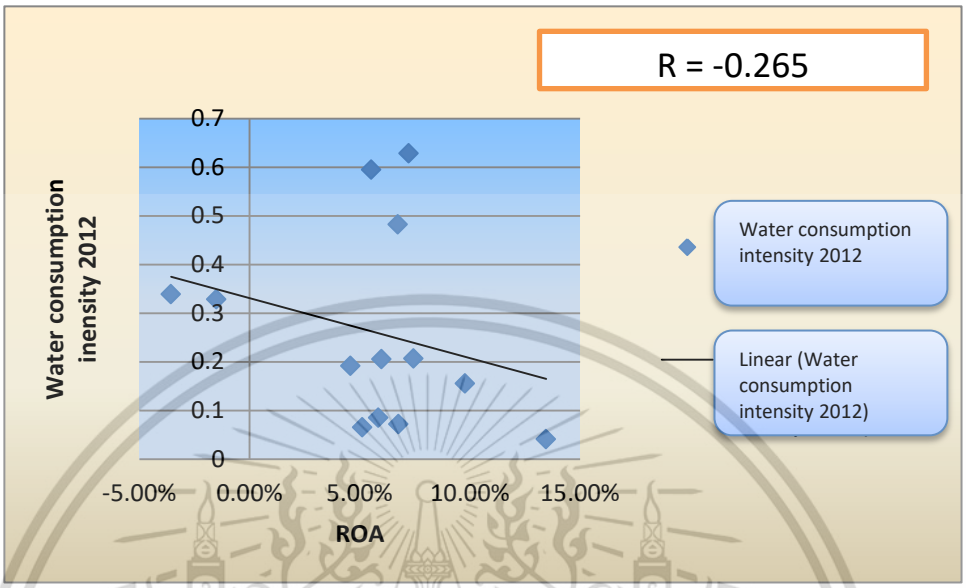


Figure R1: Relationship between Water consumption intensity in year 2013 and ROA in year 2015

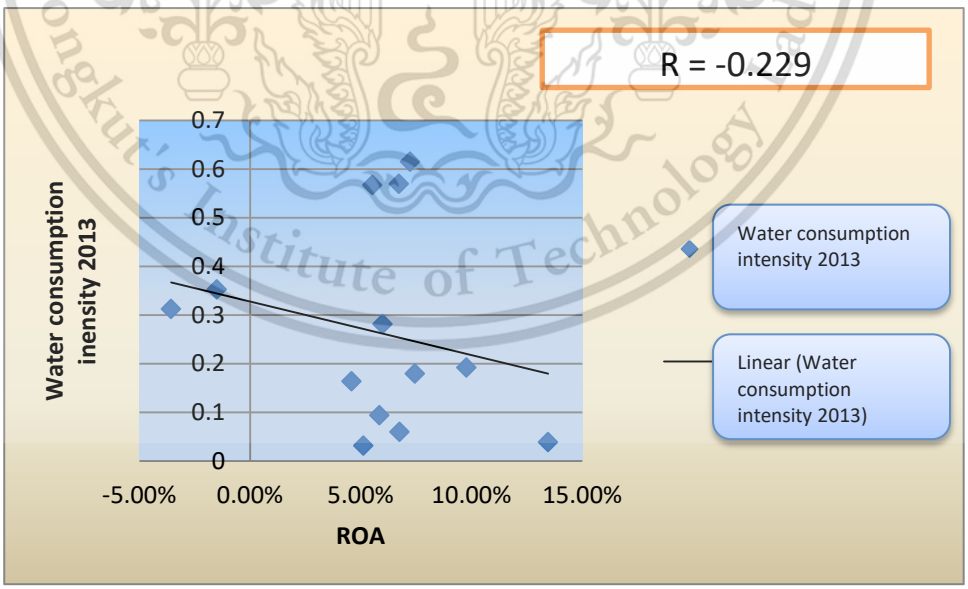


Figure S1: Relationship between Water consumption intensity in year 2014 and ROA in year 2015

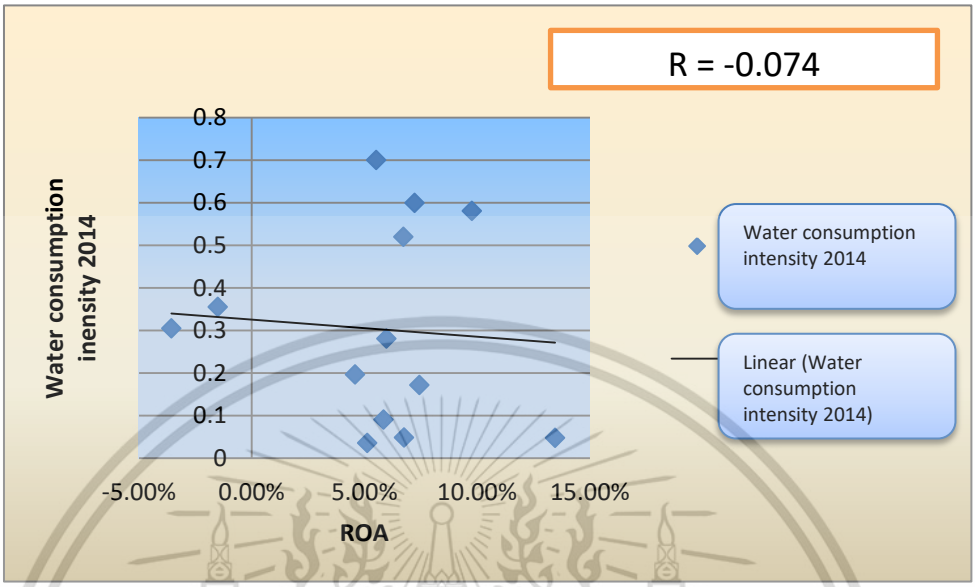
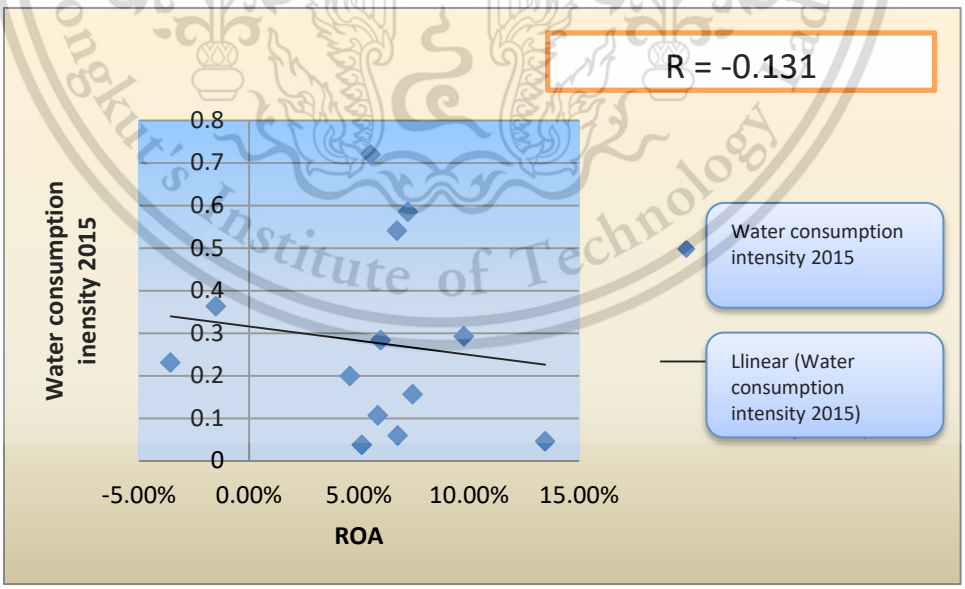
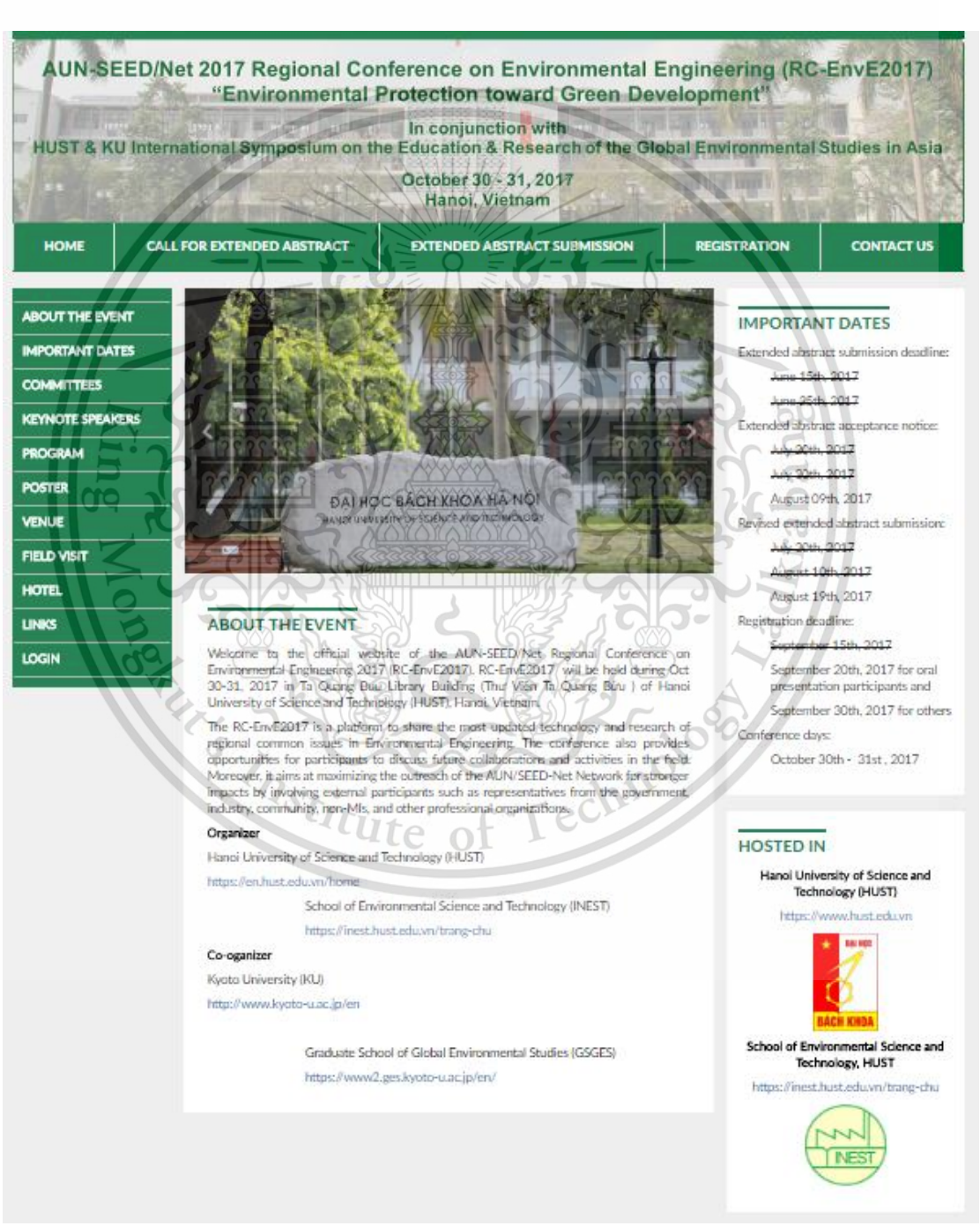


Figure T1: Relationship between Water consumption intensity in year 2015 and ROA in year 2015



APPENDIX C

AUN-SEED/Net 2017 Regional Conference on Environmental Engineering (RC-EnvE2017)



Relationship between Environmental Performance and Business Performance of oil refinery in AEC+6 countries

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Keywords: Environmental Performance (EP); Business Performance (BP); oil refinery; ASEAN Economic Community.

Introduction

Presently, many companies are proactive in terms of sustainability management. Oil refinery is one of the upstream industries that are in the eyes of investors and environmentalists regarding their Environmental Performance (EP) since this business deems as one of the major polluters to the environment. Improving EP might incur some cost and may subsequently impact the cost of downstream businesses. However, the relationship between EP and Business Performance (BP) remains unclear. Therefore, this study aims to investigate relationship between EP and BP of refineries in selected AEC+6 countries.

Material and Methods

1. Environmental Performance Evaluation

Environmental Performance Indicator (EPI) adapted from the model suggested by Japan Research Institute in 2003 is used in this study to evaluate for EP of each oil refinery. The parameters used in this study include sulphur dioxide (SO_2), nitrogen oxides (NO_x), greenhouses gas emission, energy consumption and water consumption as they are widely-accepted and reported in companies' annual sustainability report following Global Reporting Initiative (GRI) guideline. EPIs are calculated by:

$$EPI_i = O_i/T \quad (1)$$

Where,

EPI_i = Environmental Performance Indicator of pollution i

O_i = Pollution Output i

T = Refinery throughput

EPI shows the intensity of pollution that each refinery produces per unit of throughput. In petroleum industry, refinery throughput is the total amount of crude oil processed to produce petroleum products such as LPG, gasoline, kerosene, jet fuel, gasoil, and fuel oil (IPIECA, 3rd Edition 2015). Therefore, the lower EPI, the better EP each refinery performs (Reyna-Caamaño, 2001).

2. Business Performance Evaluation

Return on Equity (ROE) and Return on Asset (ROA) are used for evaluation of BP in this study. ROE is the amount of net income returned as a percentage of shareholders equity. Return on equity measures a corporation's profitability by revealing how much profit a company generates with the money shareholders have invested. ROA is an indicator of how profitable a company is relative to its total assets. ROA gives an idea as to how efficient management is at using its assets to generate earnings. ROA is sometimes showed as a percentage referred to as "return on investment" (McClure, 2005). These values are obtained from companies' annual report.

3. Correlation Coefficient between EP and BP

Correlation coefficient is a tool used to find relationship between two variables. This parameter can be in range from $-1 \leq 0 \leq 1$, while negative and positive values indicate negative and positive relationship, respectively (Cohen, Fenn, & Naimon, 1995).

Results and Conclusions

1. Environmental Performance Evaluation

Data used for the analysis is based on data presented in companies' 2015 annual reports. However, due to limitation of the data, a total of 12 refineries from 4 countries in AEC+6 were analysed including Japan, South Korea, Thailand, and India. Data of refineries from each country were averaged to represent EPIs of refineries in the country.

Table 1. EPIs of SO_2, NO_x, Water & Energy consumption and GHG emission

EPIs	SO_2 inensity (g/bbl)	NO_x intensity (g/bbl)	Water consumption inensity (m^3/bbl)	Energy consumption intensity (gj/bbl)	GHG emission intensity (t/bbl)
Thailand	26.02	15.35	0.18	0.32	0.02
South Korea	19.44	13.92	0.07	0.34	0.02
Japan	91.84	14.74	0.23	0.13	0.01
India	47.77	20.92	0.40	0.37	0.03

As presented in Table 1, on average, refineries in South Korea are ranked top in terms of water consumption, SO_2, and NO_x EPIs. Refinery in Japan performs best in terms of energy consumption and GHG emission EPIs. Refineries in India show the worst performance among all studied refineries.

2. Business performance Evaluation

Table 2. ROE and ROA of 12 refineries in 4 countries

	TH 1	TH 2	TH 3	TH 4	TH 5	JAP 1	KOR 1	KOR 2	IND 1	IND 2	IND 3	IND 4
ROE	10.51%	16.74%	19.93%	20.17%	15.19%	-24.55%	11.36%	12.27%	27.81%	11.87%	8.94%	14.65%
ROA	6.73%	7.23%	7.45%	13.46%	6.76%	-3.56%	5.13%	5.85%	9.78%	5.99%	5.54%	4.59%

BP of the refineries in terms of ROE and ROA is presented in Table 2. In contrast with EP, refineries in India and Thailand perform better in terms of BP. It should be noted, however, that BP of the studied refinery in Japan dramatically dropped in 2015 due to the impact of earthquake eruption in 2011 (EIA, 2017).

3. Correlation Coefficient between EP and BP

Table 3. Correlations between EPIs and ROE & ROA

Correlation Coefficient "R"	SO_2 intensity	NO_x intensity	Water consumption intensity	Energy consumption intensity	GHG emission intensity
ROE	-0.32	0.05	-0.03	0.20	0.36
ROA	-0.23	0.07	-0.09	0.22	0.21

EPIs data was plotted against the ROE and ROA as presented in Table 3. The results show that there is only weak relationship among all parameters. This means that achieving good EP solely may not directly impact BP of refineries. However, intangible assets and external benefits such as company's reputation and environmental and social responsibilities should also be considered as part of the outcome of being sustainable company. These additional factors are recommended to be considered in the future study.

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