ASEIC

Eco-Innovation Consulting Project in Thailand

Final Report

2016

ASEM SMEs Eco-Innovation Center

Small and Medium Business Administration

ASEM SMEs Eco-Innovation Center

Executive Summary

Overview

In tandem with global interest in and demand for eco-friendly products, services, and technologies, Eco-Innovation is serving at once as a challenge and opportunity to businesses. Due to growing energy demand and unstable energy supply from rapidly decreasing natural resources, awareness of energy conservation is spreading in Thailand. In addition, tighter regulation and higher energy costs are posing an increasing burden to businesses. Against this backdrop, this project aims to perform Eco-Innovation consulting for SMEs in Thailand so that the companies can build the groundwork for climate change response.

Expected Benefits

By providing 9 businesses in Thailand with Eco-Innovation consulting services, the ASEIC consulting team raised awareness of green management. In particular, the team was able to deliver results in various areas such as efficiently using raw materials, reducing energy consumption and greenhouse gas emissions, minimizing waste and pollutant discharge, and acquiring green certification.

Quantitative Results

In total, 50 solutions were proposed through the 2016 Eco-Innovation Consulting Project in Thailand. The potential economic benefits of these solutions are estimated to be KRW 164,746,000 (THB 229,845 or USD 140,833) per year. Moreover, the solutions have an environmental benefit of 229,845 kgCO_2 per year, which has the same effect as planting 34,825 thirty-year-old pine trees.

Qualitative Results

The project strengthened the Eco-Innovation capacity of employees in participating companies by developing solutions based on energy audits and offering professional training. It also raised awareness among senior management to encourage continuous interest in Eco-Innovation.

Partnerships

ASEIC partnered with the National Science and Technology Development Agency, (NSTDA) which is a Thai government agency that runs the Industrial Technology Assistance Program (iTAP) for local SMEs. NSTDA is a national research institute founded to improve the quality of life by integrating science and technology in various fields. iTAP provides consulting and funding for Thai SMEs to enhance their technologies and competitiveness.

ASEIC and NSTDA discussed plans to continuously carry out the consulting project and to focus on the participating companies' areas of common interest. They also agreed on follow-up measures to monitor the issues and progress of each company.

By engaging the interest of the Thai government on Eco-Innovation, ASEIC created an opportunity for the government to operate its own program after the consulting is complete.

Other Remarks

A survey conducted among participating companies showed a 69.3% increase in their awareness of Eco-Innovation after receiving the consulting, a 93.3% satisfaction rate with the project, and an 86.7% satisfaction rate with the solutions. One of the main suggestions made by participating companies and government agencies was to provide more training opportunities through capacity-building programs.

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01 Project Background

1.1 Eco-Innovation

Background on Eco-Innovation

In line with growing demand for eco-friendly products, services, and technologies, Eco-Innovation is serving at once as a challenge and opportunity to businesses. An increasing number of green consumers are considering a product's environmental impact at every stage of its life cycle before they decide to purchase it. Corporate environmental responsibility has come to the fore as environmental regulations grow stricter and the international community engages in a deeper conversation on tackling climate change.

In December 2015, the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Paris Agreement, which requires both developed and developing countries to reduce emissions and submit their Intended Nationally Determined Contributions (INDCs). Accordingly, policymakers worldwide are expected to push for stronger regulations on energy and climate change. For businesses to generate profit in this environment, they must use limited resources and streamline their production while complying with various regulations. Eco-Innovation presents an opportunity for businesses under such strenuous circumstances.

Basic Concept of Eco-Innovation

The concept of Eco-Innovation, which originally referred to eco-friendly approaches to industrial waste treatment, is increasingly expanding in scope to include innovation in manufacturing processes, green product design, and sustainable services. Furthermore, the concept is evolving to encompass energy and natural resource efficiency, comprehensive systems for green production, and new business models that reflect consumers' interest in eco-friendly products . Eco-Innovation is innovation that promotes the sustainable development of businesses through a wide spectrum of activities as mentioned above.

Put differently, Eco-Innovation technology is any technology that facilitates a business' sustainable development by minimizing the burden its products impose on the environment throughout their life cycle. Not only does this include technologies to prevent or mitigate waste generation while manufacturing a product, but also those to reduce the environmental impact of a process, system or service. Eco-Innovation refers to all technologies that reduce emissions and waste by conserving energy and raw materials or removing hazardous substances, and in doing so, minimize adverse effects on safety, health, and the environment.

Eco-Innovation is applicable to all industries, and its key underlying idea is to build a sustainable society through pollution reduction and resource efficiency.

| Table 1 | Definitions of Eco-Innovation

Organization	Definition
European Commission (EC)	any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of resources including both intended and unintended environmental effects from innovation as well as not only environmental technology but processes, systems and services
Eco Innovation Observatory (EIO)	any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle
ASEM SMEs Eco-Innovation Center (ASEIC)	an idea to achieve environmental improvements, to enhance competitiveness of enterprises and to provide new business opportunities by means of using low cost and non-technology-intensive methods

1.2 Promotion of Eco-Innovation

| Figure 1 | Promotion of Eco-Innovation

While Eco-Innovation is emerging as an important issue worldwide and the need for it is being recognized, there are still many SMEs in Europe and Asia that lack the technology and awareness to practice it, which is decreasing their competitiveness and costing the environment. Since its inauguration, ASEIC has strived to improve ASEM member states' capacity for Eco-Innovation so that they can achieve eco-friendly and low-carbon green growth. Now that they have a stronger capacity for Eco-Innovation, their next focus should be on sharing technologies and experiences with each other to solve global environmental problems together. This project aims to facilitate this process by providing practical assistance to SMEs in ASEM member states, such as sharing success stories and spreading awareness of Eco-Innovation.

Accordingly, the 2016 Eco-Innovation Consulting Project worked with the government and other relevant organizations of Thailand to lay the foundation for promoting Eco-Innovation and building local competencies.

02 Consulting Methodology

2.1 Project Objectives

| Table 2 | Objectives of Eco-Innovation Consulting Project in Thailand

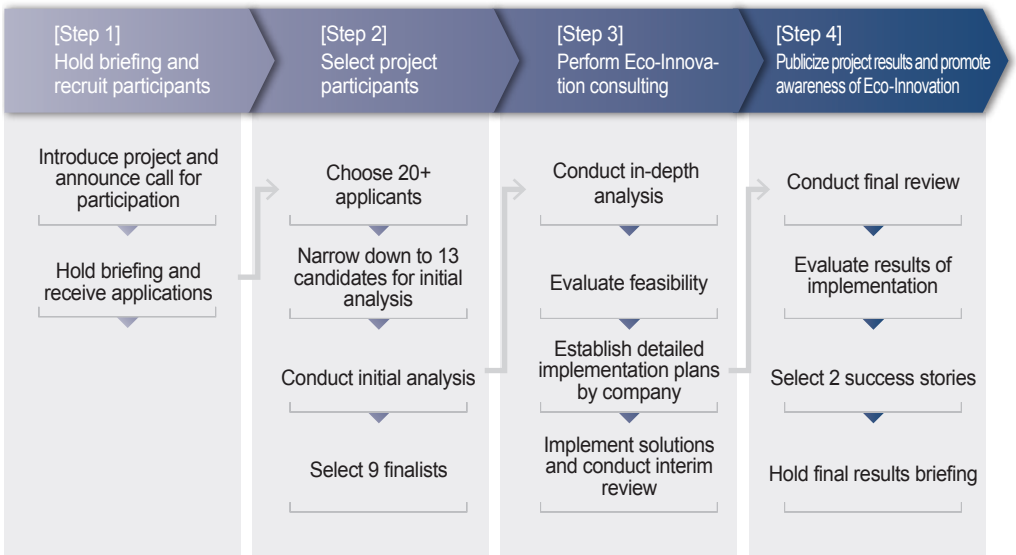
	Objective	Target	Actual	Target-Actual Comparison
Environmental Management & Service Improvement	Increase participants' awareness of Eco-Innovation	Increase by 20%+	Increased by 69.4% on average	247%
	Build self-sustaining Eco-Innovation system	1+ cases	2 cases	200%
Process Improvement	Increase efficiency in the use of raw materials	5+ cases	5 cases	100%
	Reduce energy use and greenhouse gas emissions	10+ cases	19 cases	190%
	Reduce environmental emissions	5+ cases	10 cases	200%
	Increase process management efficiency	5+ cases	13 cases	260%
Publicity & Promotion	Publicize results	1 case	2 cases	200%
	Hold results briefing	1 case	1 case	100%

2.2 Detailed Plans and Methods

Project Delivery Framework

The delivery framework of this 8-month project largely consisted of four phases: reach out to the local government and establish partnerships, hold seminars and select companies to participate in the project, perform Eco-Innovation consulting, and publicize project results and promote awareness of Eco-Innovation.

| Figure 2 | Project Delivery Framework



STEP 1. Hold Briefing and Recruit Participants

To execute the Eco-Innovation Consulting Project in Thailand, a local partnership was established with the National Science and Technology Development Agency (NSTDA). NSTDA is a national agency of Thailand founded to improve the quality of life by integrating science and technology in various fields. In particular, the Technology Management Center (TMC), which is the general management division of NSTDA, was selected to work closely with ASEIC in carrying out the Eco-Innovation Consulting Project. Through the Industrial Technology Assistance Program (iTAP), TMC provides consulting, training, technology matching, and funding to SMEs in Thailand to increase their technological prowess and competitiveness. In addition, Chulalongkorn University's engineering department was enlisted to offer technical

support to local SMEs. A team of experts consisting of the department's faculty members was responsible for the actual consulting, from assessing the companies participating in this project through inspecting their facilities to developing solutions.

TMC sent out a call for local SMEs to participate in the Eco-Innovation Consulting Project and worked with other government agencies in Thailand to recruit companies. On June 9, 2016, a Project Briefing was held in the SME Bank Tower in Bangkok for Thai SMEs, government agencies, and research institutions interested in the project. The briefing covered a range of topics including a project overview, action plan, past success stories, and environmental policies of Thailand.

| Figure 3 | Project Briefing

Greetings from Government Agencies

Introduction on ASEIC

Overview of Consulting Project and Success Stories

Discussion on Environmental Policies of Thailand

STEP 2. Select Project Participants

Following the Project Briefing, ASEIC and NSTDA jointly selected a pool of candidates from the companies that wished to participate in the project. 12 companies applied for the project, of which one was excluded because it did not qualify as an SME and two dropped out of the project shortly before consulting began.

The consulting team conducted an on-site analysis of the 12 candidates to select the final participants. This on-site analysis involved interviews of the candidates based on their questionnaire responses and identified their needs, potential solutions, and possibilities for generating economic and environmental benefits.

The questionnaire's goal was to obtain a profile of each company and understand their production process. The "company profile" section of the questionnaire asked respondents to give a company overview and describe their main products, production process, purpose of participation, and prior activities related to Eco-Innovation. The "production process" section asked respondents to provide information on plant layout, production process flow charts, the use of raw materials and energy, and the amount of waste, wastewater, and air pollutants produced.
The main purpose of the questionnaire was to identify each company's consulting needs in the following 4 areas of Eco-Innovation: eco-friendly management, process, product, and service.

| Figure 4 | Sample Questionnaire

Worksheet 1	Company Profile
Worksheet 2-1	Input Data(Raw Material)
Worksheet 2-2	Input Data(Energy)
Worksheet 3-1	Plant layout & Process
Worksheet 3-2	Facility & Equipment
Worksheet 3-3	Product & Service
Worksheet 4	Eco-friendly management
Worksheet 5	Expectation of Consulting

<Sample Questionnaire Response>

Based on the analysis results, the consulting team chose the final 9 companies to participate in the project.

Initial Analysis

| Table 3 | Initial Analysis Process

No	Action	Details	Duration
1	Introduce project	Provide overview of Eco-Innovation Project and action plan	5 min
2	Interview staff in charge	Identify main consulting needs and areas for improvement through interview	30 min
3	Visit site	Inspect production facilities and identify solutions	60 min
4	Discuss solutions	Discuss solutions and reach agreement on details	30 min
5	Discuss next steps	Set next steps and timeline (specific to each company)	5 min

The purpose of the initial analysis was to determine solutions as part of the Eco-Innovation Consulting Project. The initial analysis included a project introduction, interviews, site visits, and discussions on solutions and next steps. After the initial analysis, ASEIC compiled feedback from professional consultants and provided an initial analysis report to participating companies.

| Figure 5 | Sample Initial Analysis Report

1. Company Profile

Established year	1983	Number of Employees	140
Type of Industry	Furniture	Sales Volume (USD/yr)	3,000,000
Main Product	Cabinet	Location	Bangkok

3. Site Visit

Visit business site

Introduction of process line

2. Process Chart

Coating PVC/paper on particle board → Cutting particle board → Finishing cutting edge and assembling → Packing

4. Detected Problem

- Energy guzzling process : Edging, Product washing process by Air-blowing
- Small and large air compressors are 100% operated but working load for small AC is low
- Saw-dust from particle board cutting process is sold as fuel for thermal power generation

STEP 3. Perform Eco-Innovation Consulting

In-depth Analysis

| Table 4 | In-depth Analysis Process

No	Action	Details	Duration
1	Discuss schedule	- Discuss schedule for in-depth analysis	5 min
2	Share results of initial analysis	- Share results of initial analysis - Explain main consulting solutions and collect related data	60 min
3	Conduct in-depth analysis	- Conduct on-site analysis and interview staff in charge to help develop solutions - Examine data for in-depth analysis - Discuss feasibility of solutions	120 min
4	Discuss next steps	- Set timeline for solution implementation	10 min

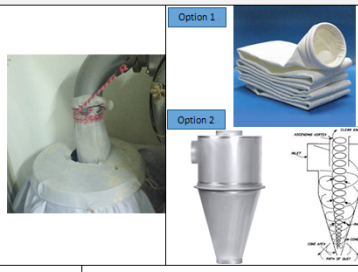
The purpose of the in-depth analysis was to conduct a detailed assessment and estimate the expected benefits of each solution. To aid the implementation of solutions, the ASEIC consulting team analyzed the technical and economical feasibility of solutions, established the necessary plans accordingly, and shared case studies and other information on technology deployment.

| Figure 6 | Sample In-depth Analysis Report

1. GIB-Green Innovative Biotechnology Co., Ltd.

Company Profile	
Field of business	Manufacturing
Main products	Organic fertilizer
Year of foundation	2015
Number of employee	10

■ **Solution**

# Item 1 : Reduction in raw material	
	
Problem	Raw material loss from exhaust air of fluidize dryer. (estimated loss of RM =1 kg / batch at 10 kg).

Solution	For collecting small particle of raw material, the solutions are : Option 1. Using dust filter bag. The bags require small space and include the return of collected dust to main raw material and low installation cost. The following key factors to select the bag are : • Temperature – operating temperature that bags need to withstand. • Product – what is being filtered? • Particles – size of the dust particles that are being filtered. • Filter media – types of Filter Media. Option 2. Installation cyclone separator to separate solid (Fine RM particle) and fluid (Air). This option is the long term after company trial with dust filter bag). Data collection of cyclone separator for design calculation : • Particle size distribution. • Flow rate of exhaust air (Airspeed/Air Volume). • Material use.
Benefits	Saving raw material about 10 %. • Cost saving o Assumption : operating 8 hrs./day for 300 days/year. : drying time 40 mins/batch. o Bulk price is 500 baht/kg. o Therefore, company will save 1.8 million baht/year. (If they run production capacity like this assumption) For the calculation as following : - From above operating assumption, the company can run the production for (8 hrs./day×1.5 batches/hr.) 12 batches/day or (12 batches/day×300 days/year) 3,600 batches/ year. — Cost saving is (3,600kg/ year×500 baht/kg) 1.8 million baht/year. - And the separator can collect raw material about 1 kg/batch. - Therefore raw material saving is (3,600 batches/year×1 kg/batch) 3,600 kg/year.

Depending on each company's needs, the ASEIC consulting team provided customized Eco-Innovation training on process improvement, energy conservation, waste treatment, environmental regulations, and/or green certification.

Feasibility Study and Detailed Implementation Plan

The ASEIC consulting team assessed the economic and technical feasibility of the final solutions. The team took into consideration the difficulty of implementing the solutions, required investment costs, payback period, and expected benefits in order to help each company make the right investment decision. In addition, the team established detailed implementation plans, as shown in <Figure 7>, considering the applicability and priority of each solution.

| Figure 7 | Detailed Implementation Plan

Eco-Innovation Consulting Project Implementation Plan

Company Name : Vincita Co., Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Software for calculating fabric cutting size	yes	/		
2	Design step of marking point	yes		/	
3	Collect in-out data for each process	yes			/
4	Replace with high efficiency lamp	yes		/	
5	Reuse remnant of cloth	yes		/	

※ Implementation Plan marked by long-term, mid-term and short-term

Above improvement items were obtained by Eco-Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the internal reviews

Person in Charge : Pasarapa Sinhaseni

STEP 4. Publicize Project Results and Promote Awareness of Eco-Innovation

Final Results Briefing

A final results briefing was conducted to report and publicize the expected benefits of the 2016 Eco-Innovation Consulting Project. The briefing covered environmental policies of Thailand (LCA), results of the consulting, and two success stories from the project. In addition, all participating companies were awarded Eco-Innovation Project Completion Certificates by ASEIC.

| Figure 8 | Final Results Briefing

Greetings from Government Agencies

Overview of LCA and Why It Is Needed

Presentation on Consulting Results and Success Stories

ASEIC Certificate Award Ceremony

Publicity and Awareness Promotion

To publicize the expected benefits and need for Eco-Innovation consulting, the team leveraged the NSTDA website and its social media channels. It also promoted through radio to get the word out about the launch of the project.

03 Thailand's Energy and Business Environment

3.1 Energy Usage

With Thailand's energy supply in 2015 at 135,496 ktoe (thousand tonnes of oil equivalent), the country's overall energy supply and energy imports have been on the rise. Industrial sectors including manufacturing accounted for 35.9% of Thailand's total final energy consumption in 2015, second only to the transportation sector (36.6%). Energy demand is rising steadily, yet the country is in need of stable supply as it faces a shortage of natural gas, its primary energy source, as well as heavy opposition from residents on constructing coal-fired power plants. Thailand's Ministry of Energy predicts that the country's annual LNG demand, which currently stands at 5 million tonnes, will reach 22 million tonnes in 2036. However, supply security will still remain an issue: natural gas reserves buried in the Gulf of Thailand is expected to deplete completely within five to six years, while Myanmar, where Thailand imports a bulk of its natural gas supply from, is exporting a growing share to China. Energy security has thus become an major national challenge in Thailand due to the increase in energy demand and the decrease in production from resource depletion.
Naturally, awareness of energy conservation is spreading in Thailand, while various regulations and higher energy costs are posing increasing burden to businesses.

3.2 SMEs in Thailand

At the end of 2013, the number of companies in Thailand was 2.84 million, of which 2.76 million were SMEs, accounting for 97.16%. SMEs, which make up the vast majority of local companies, are aware of the importance of Eco-Innovation in line with the Thai government's energy policy and the demand for stronger internal and external competitiveness. However, they do not have enough information and thus get few concrete opportunities to practice Eco-Innovation. The Thai government has created programs to support businesses yet they fall short of demand. This consulting project therefore seeks to help boost the eco-efficiency of SMEs in Thailand and spread awareness of Eco-Innovation.

04 Success Stories of Eco-Innovation Consulting in Thailand

4.1 Adoption of Dust Collection System to Save Raw Materials

Summary

The company in this case study produced organic fertilizers by mixing, grinding, and reacting raw materials. It had a relatively simple production process that consisted of raw material storage and input, mixing with auxiliary materials, reaction, grinding, and packaging.

During the mixing and grinding processes, however, the company was losing a significant amount of raw materials to the atmosphere. The ASEIC consulting team found that approximately 10% of the raw materials used were dispersed into the air in powder form.

The ASEIC consulting team therefore proposed a dust collection system, which would allow the company to collect and reuse granular raw materials in the air and satisfy its need to save raw materials and enhance production efficiency. Of the types of dust collectors available, the team recommended either cyclone separators or bag filters, but as the former required the company to consider many factors before deployment, it suggested starting with the latter first.

Consulting Background

The bulk price of the company's raw materials was THB 500/kg in local currency and KRW 16,000/kg in South Korean currency. This amounted to a fairly high sum compared to local prices and added cost pressures to the company. In addition, the company was producing only 20% of its total capacity and had mid to long-term plans to increase that amount to 80%. Thus the company expressed a strong need to reduce its use of costly raw materials, more so than any other Eco-Innovation category. A related issue that required attention was the dispersing of product particles in the air during production and how it adversely affected the work environment.

To address these issues, the consulting team searched both at home and abroad for technologies that could effectively collect and recycle the powdered product, and developed

various methods that would allow the company to deploy an appropriate technology based on its investment capacity and level of commitment.

Technical Barriers

Dust collectors, which the consulting team recommended to the company, were already being used by larger companies in South Korea as well as Thailand as a means to prevent air pollution. Yet SMEs in Thailand had not been able to avail themselves of the technology because they lacked relevant information. To use a dust collection system, the company would have to consider air flow and the equipment's operating temperature. It would also need to spend a lot of time collecting data before introducing the system, such as identifying particle size and dispersion pattern. Therefore, the consulting team proposed using bag filters, which were easily implementable, in the short term and transitioning into cyclone separators in the long term.

Selection and Implementation of Solution

The company had a relatively simple production process that involved: raw material storage and input, mixing with auxiliary materials, reaction, grinding, and packaging. In the mixing and grinding processes, one mixer and two grinders were operated, respectively. The consulting team found that the mixer and grinders lost about 10% of the raw materials put into them, which called for improvement.

Moreover, the company was preparing to acquire the Good Manufacturing Practice (GMP) certification. The GMP certification is granted to firms manufacturing safe, quality food or drug products by practicing strict process management that eliminates any errors during production and minimizes pollution. The company thus had a pressing need to reduce the dust levels in the air and improve the work environment.

A bag filter is a type of dust collector and filter. It filters out particles through a high-density mesh constructed from a blend of resin and fibers like cotton, wool, and fiberglass. When it is used over a long time, dust will build up inside it and require regular cleaning. Due to the properties of the material, it is not generally suitable for high temperatures, but it has high collection efficiency because its wide surface area covers a lot of air flow. It is also relatively cost-effective and easy to deploy.

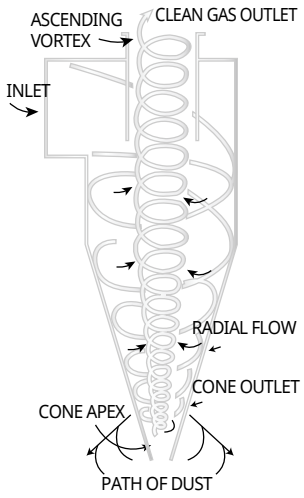
After discussing with the consulting team, the company decided to use bag filters first. However, bag filters need frequent replacing as they are not highly durable. Considering such operating conditions and economic aspects, bag filters

| Figure 9 | Bag Filter

have clear limitations from a long-term perspective. On the other hand, cyclone separators are economical, have a simple structure, and can withstand harsh operating environments, which is why they have been widely used across various industries.

Cyclone separators extract solid or liquid particles from gas using centrifugal force generated by rotating the gas. As gas flows through a cylinder-shaped cyclone in a spiral pattern, particles move toward the cylinder wall and settle to the bottom, while clean gas spirals up and exits out the top. Cyclone separators have high collection efficiency and do not decrease much in efficiency even over a long period of time. Also, they are easy to install and maintain, and take up only a small amount of space.

| Figure 10 | Cyclone Separator



On the downside, they are expensive to install and require prior research on air flow and the dispersion pattern of dust because they respond sensitively to changes in flow rate and dust load.

Under the consulting team's guidance, the company began using bag filters. It also agreed to work with NSTDA to conduct a feasibility study on using cyclone separators. If test bed results suggest high feasibility, it will adopt cyclone separators in accordance with its mid to long-term business plan.

Consulting Results

| Table 5 | Calculation of Expected Benefits from Solution

Estimated Raw Material Savings After Implementation
• Loss of raw materials: 10% of raw material input
• Operating conditions of mixer and grinder: 12 batches/day, 300 days/year
• 1 batch = 10 kg, THB 150/kg
• Raw material savings
= Daily input amount to mixer and grinder X operating days X 10%
= 12 batches/day X 300 days/year X 10%
= 360 batches/year
= 3,600 kg/year
• Expected economic benefit from raw material savings
= 3600 kg/year X THB 150/kg
= THB 1,800,000/year
= KRW 60,000,000/year

If lost raw materials are recovered with dust collectors and reused, the company is expected to save 3,600 kg of raw materials per year, as shown in <Table 5>. This translates to an economic benefit of about KRW 60,000,000 every year. The above result is calculated based on the amount of raw materials lost at the present time, meaning that when the current production capacity of 20% improves and more raw materials are inputted, the economic benefit of using dust collectors is expected be even greater. In addition, bag filters have an extremely low installation cost of USD 20, so the payback period would also be short. Cyclone separators have an estimated payback period of one year.

Dust collection is an effective technology that is already widely used across many industries. Bag filters are particularly effective relative to their price, and being so inexpensive, they can be employed by even a small business without straining its financial position. As for cyclone separators, they can remove great amounts of heavy, large particles generated from wood or stone processing and drilling operations. The consulting team thus hopes that this company's success will serve as a case study for other companies not only in the same industry but also in various industries, and contribute to increasing their competitiveness in saving raw materials, improving working environments, and recycling.

4.2 Cascade Rinsing for Water and Energy Conservation

Summary

The company in this case study manufactured parts for freight vehicles (e.g. U-Bolt and Bush). Its production process consisted largely of cutting, heating, molding, machining, and cleaning metal. Electricity was its main energy source, and it spent most of its energy supply on heating and cutting metal.

As waste oil and foreign substances stuck to metal surfaces during production, the cleaning process was necessary to improve the quality of finished products. The company used hot water to wash all products. The issue here was that large amounts of water went into the process and energy was being spent unnecessarily to heat up water. Furthermore, the wastewater generated from cleaning metals was flowing straight out of the factory, exacerbating environmental pollution. Meanwhile, the cleaning equipment being used was assembled by the company itself and had low efficiency. To help the company save energy and efficiently use raw materials as per its request, the ASEIC consulting team proposed counter-current rinsing. Through this solution, the company can expect to save around 3,600 kWh of energy and KRW 700,000 (THB 20,725) annually.

Consulting Background

The company produced freight car components for local and overseas markets, and was increasingly lagging behind in price competition with Chinese companies that automated mass production. This had prompted the company, prior to participating in this project, to work with the local government in conducting research and development on improving product quality. Its collaboration with NSTDA, this project's partner, had proved particularly successful through iTAP. However, it had never received consulting on process management or saving energy. The company needed to boost efficiency in energy and raw material usage in order to cut unit production costs and increase price competitiveness with Chinese manufacturers.

Thailand generally supplies water at low prices to companies located in industrial complexes, and charges regular fees to other businesses. The difference in price is not great, but it can add up to a significant sum for companies that use large volumes of water during production. As this company used excessive quantities of water to remove impurities created in the manufacturing process, it had to become more efficient.

To this end, the consulting team conducted research on appropriate technologies to curtail water usage and minimize energy consumption while producing hot water. Based on these findings, the team suggested various measures to the company.

Technical Barriers

As counter-current rinsing does not yield huge economic benefits relative to cost in the short run, the consulting team had to persuade the company to adopt the method. The company would not have been so hesitant to convert to counter-current rinsing if the payback period was short, especially since it uses so much water. Yet since the technology was not immediately profitable, the company's reservations were only natural. The consulting team thus convinced the company by highlighting positive effects the shift would bring in addition to saving water, such as cutting down energy consumption and pollutant discharge.

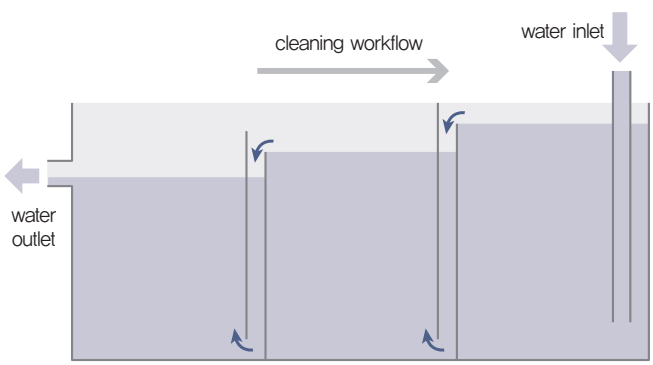
| Figure 11 | Cleaning Equipment

Selection and Implementation of Solution

Cleaning is a process of removing various contaminants remaining on the surface of a product. Industries employ many different cleaning methods. Cleaning operates on a chemical or physical mechanism, and today, new mechanisms are being developed, such as those that employ ultrasonic waves, plasma, or heat. Meanwhile, the company in this case study was cleaning products with water using a machine it had developed internally, as pictured in <Figure 11> below. However, rinsing the products with hot water was not enough to wash all the debris clean, including the lubricant used in polishing, waste oil from cutting, and sand. Every rinse required around 1㎥ of water, and the machine ran ten times a day for 200 days a year. Additionally, the hot water was produced by water heaters that operated 20 hours per day for 300 days every year.

This machine was old and inefficient, and had to be replaced by a new rinsing method. Of the various rinsing methods described above, chemical methods that use acid solutions, deionized water, etc. can effectively eliminate impurities from products. However, this approach would require an additional production step to treat the chemical wastewater, so the consulting team decided to develop a more sustainable solution from a long-term perspective. The team suggested that the company continue rinsing products in water without adding any cleaning agents, but that it should employ a counter-current setup.

| Figure 12 | Illustration of Counter-current Rinsing



Counter-current rinsing is a method where water enters the last tank, as shown in <Figure 12>, and flows from tank to tank in the opposite direction of the rinsing workflow until it exits via the first tank. This simple mechanism is highly effective at conserving water. There is no need to continuously supply water to the tanks: the water in the first tank is drained when it reaches a certain level of contamination, and the cleanest water from the last tank can be mostly reused. The company decided to build and use a four-stage rinsing system in order to effectively remove debris.

Consulting Results

| Table 6 | Calculation of Expected Benefits from Solution

Estimated Savings from Reducing Water and Energy Use
• Operating conditions of rinsing system: 10 operations/day, 200 days/year • Operating conditions of water heaters: 2 hours/day, 300 days/year Price of water: THB 15 /㎥, price of electricity: THB 4/kWh • Energy savings = daily operation hours of heaters X days of operation in a year X rated capacity = 2 hours/day X 300 days/year X 6 kW/hour = 3,600 kWh/year
• Water savings = Water usage before implementing solution - water usage after implementation = (10 operations/day X 200 days/year) X 1 ㎥/operation - 1,587.314 ㎥/year = 2,000 ㎥/year - 1,587.314 ㎥/year = 412.686 ㎥/year • Expected economic and environmental benefits Economic benefit = (412.686 ㎥/year X THB 15/㎥) + (3,600 kWh/year X THB 4/kWh) = THB 20,725.29/year = approx. KRW 700,000/year Environmental Benefit = 3,600 kWh/year X 0.4662 kgCO_2/kWh = 1,678.32 kgCO_2/year

By replacing its original cleaning method with the counter-current rinsing system, the company is expected to save 412 ㎥ of water per year, as presented in <Table 6>. In addition, every year it can save an estimated 3,600 kWh of energy when producing hot water. Such water and energy savings translate to an economic benefit of around KRW 700,000 per year. The expected payback period of building the rinsing system is two to three years.

Although nearly every industry differs in the degree and method of cleaning and the type of cleaning agents used, cleaning is always an essential part of production. For companies in industries that consume large amounts of water, cascade rinsing, including counter-current rinsing, can be a powerful solution.

05 Expected Benefits of 2016 Eco-Innovation Consulting Project in Thailand

5.1 Expected Benefits at a Glance

The 2016 Eco-Innovation Consulting Project in Thailand produced a total of 50 solutions. If they are implemented in full, the participating companies are expected to save KRW 164,746,000 (THB 229,845 or USD 140,833)[1] per year in terms of economic benefits. The environmental benefits of the solutions are estimated to be around 230 tCO_2 per year, which has the same effect as planting 34,825[2] thirty-year-old pine trees. 46% of the solutions have been implemented to date, and it is hoped that the companies continue to deploy more solutions in the long term and that this report serves as a quantitative guide.

| Table 7 | Expected Benefits by Consulting Area[3]

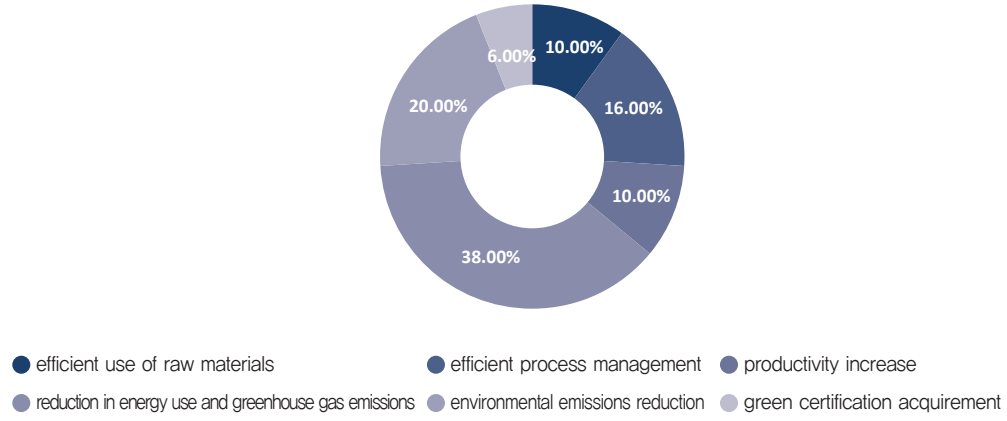
Consulting Area	Number of Solutions	Expected Economic Benefit (Unit: KRW 1,000)
Efficient use of raw materials	5	66,270
Efficient process management	8	4,946
Productivity increase	5	60,038
Reduction in energy use and greenhouse gas emissions	19	33,037
Environmental emissions reduction	10	456
Green certification acquirement	3	-
Total	50	164,746

A total of 9 companies participated in the Eco-Innovation Consulting Project in Thailand. They came from various sectors: one from metal processing, two from textile production, two from

1) Exchange rate: THB 1 = KRW 32.97, USD 1 = KRW 1169.80 (source: KEB Hana Bank, as of
2) Source: "Standard Carbon Sequestration Levels by Major Forest Tree Species," Korea Forest Service, 2012
3) Expected benefit assuming 100% implementation rate

wood processing, three from food manufacturing, and one from biotechnology. As shown in <Table 7>, 38% of the solutions centered on reducing energy use and greenhouse gas emissions, 20% on reducing environmental emissions, and 16% on driving efficient process management.

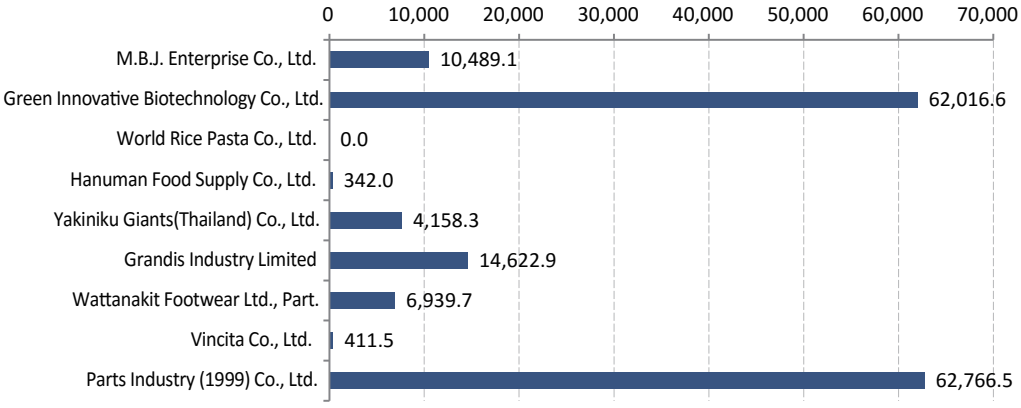
| Figure 13 | Breakdown of Consulting Areas



5.2 Expected Economic Benefits

Among the companies that participated in this project, Parts Industry (1999) Co., Ltd. is expected to gain the highest economic benefit from the consulting with KRW 62,766,500 per year, followed by Green Innovative Biotechnology Co., Ltd. with KRW 62,016,600 per year. The expected economic benefits vary considerably by company; this seems to stem less from their difference in size than from the fact that the consulting catered to different needs of each company.

| Figure 14 | Estimated Economic Benefits by Company

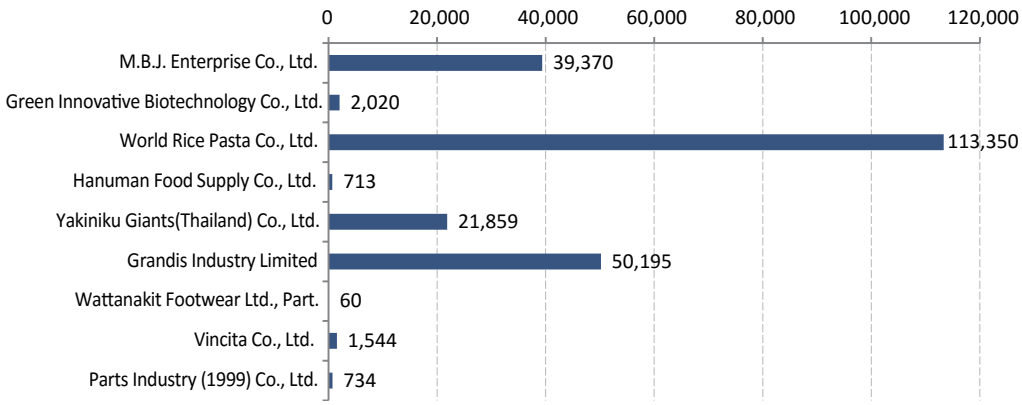


As mentioned above, Parts Industry (1999) Co., Ltd. and Green Innovative Biotechnology Co., Ltd. are expected to obtain relatively high economic benefits. This is because the consulting team developed solutions that took into account their needs and nature of business. Some companies such as World Rice Pasta Co., Ltd., Hanuman Food Supply Co., Ltd., and Vincita Co., Ltd. are not expected to benefit as much financially because the solutions proposed to them focused less on generating economic benefit and more on production management. Furthermore, the consulting team found it difficult to recommend some solutions to smaller businesses because they would put cost pressures on the businesses despite having great payoffs. On the other hand, the companies that opted to invest in their facilities to use raw materials more efficiently, improve processes, and save energy are anticipated to reap substantial economic benefits.

5.3 Expected Environmental Benefits

As illustrated in <Figure 15> below, the ASEIC consulting team took each company's expected energy savings and converted them into $kgCO_2$ based on the carbon emission factors specified in IPCC guidelines and the carbon emission factors for electricity consumption indicated in a South Korean national database. Out of the companies that participated in the project, World Rice Pasta Co., Ltd. and Grandis Industry Limited are expected to gain the most from the consulting in terms of environmental benefits. These companies are larger in size and consume more energy, and would therefore gain greater environmental benefits. For companies that would not benefit as much environmentally, the consulting team focused on other areas such as process management, production management, and work environment improvement.

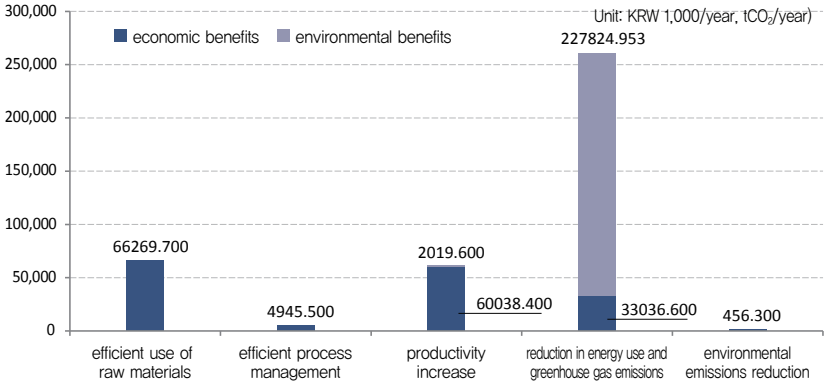
| Figure 15 | Estimated Environmental Benefits by Company



5.4 Overall Expected Benefits

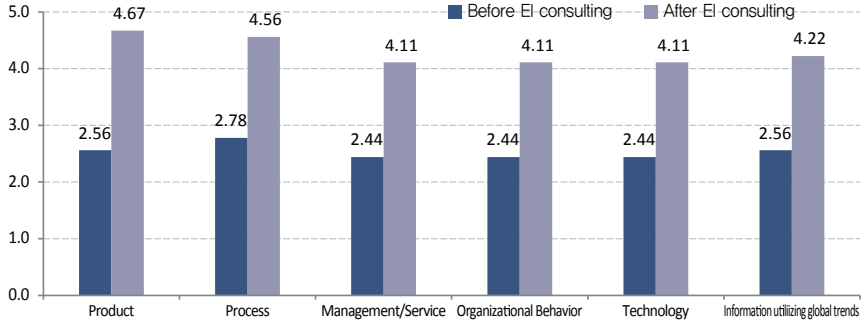
This Eco-Innovation consulting project enabled the efficient use of raw materials, reduction in energy use and greenhouse gas emissions, environmental emissions reduction, efficient process management, and productivity increase. When these results are converted into monetary value, the efficient use of raw materials generates the highest value (KRW 66,270,000 per year), even though it is not the consulting category with the most number of solutions. The category with the second highest monetary value is productivity increase (KRW 66,038,000 per year). In addition, measures aimed at reducing energy use and greenhouse gas emissions made up the largest share of solutions. As the SMEs in Thailand that participated in this project had never received an energy audit, the consulting team proposed a considerable number of energy-related measures.

| Figure 16 | Estimated Economic and Environmental Benefits by Eco-Innovation Consulting Area



As for environmental benefits, reducing energy use and greenhouse gas emissions is expected to have more impact than any other consulting area. This is because reducing energy consumption (e.g. oil, gas, and electricity consumption) leads to lower carbon emissions, and the amount of energy saved is directly proportional to the level of environmental benefit.

| Figure 17 | Eco-Innovation Awareness Improvement Survey



A survey was conducted before and after the Eco-Innovation Consulting Project to measure the change in the participating companies' awareness of Eco-Innovation. The survey assessed Eco-Innovation awareness under 6 categories: product, process, management and service, organizational behavior, technology, and information. The results showed that the companies' awareness improved by 69.3% on average.

Results by category showed that the highest improvements occurred in "product" (82.6%), "management and service" (68.2%), and "organizational behavior" (68.2%). This was due to the participating companies' high level of interest in these topics, which led to a correspondingly high number of related solutions.

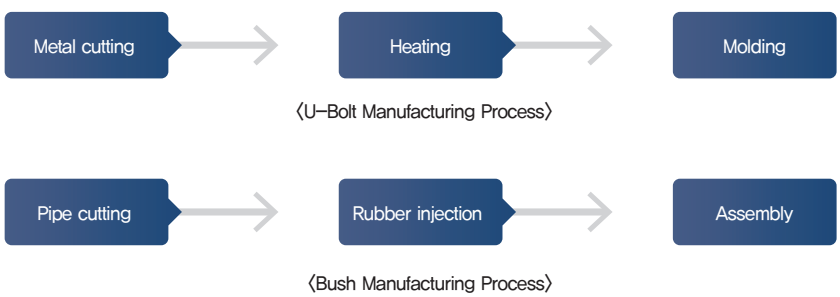
5.5 Expected Benefits by Company

4.5.1 Parts Industry (1999) Co., Ltd.

Company Profile

Established in 1978, Parts Industry (1999) Co., Ltd. is a family-run business manufacturing automobile components such as U-bolts and bushes. It offers customized products based on client orders. Its production process consists of metal cutting, heating, and molding.

| Figure 18 | Production Process



As <Figure 18> shows, the company manufactures U-bolts through metal cutting, heating, and molding. It produces bushes through pipe cutting, metal injection, and assembly. Out of these processes, heating metals consume the highest amount of energy. In addition, as most of the U-bolt molding and bush assembly processes are done by hand, production efficiency is low while labor costs and defect rates are high. The company's main concerns thus include reducing energy consumption, waste, and costs.

Current Issues and Consulting Needs

Prior to the consulting project, Parts Industry (1999) Co., Ltd. had already participated in a variety of SME support programs organized by iTAP and strived to promote eco-friendly production processes. However, its production facilities were as old as 25 to 30 years and most of its production processes were done manually, which altogether lowered the company's productivity. Accordingly, the company wanted to adopt a computer-aided control system instead. It was also interested in decreasing the amount of energy consumed by its production facilities because processes like metal heating during U-bolt and bush production were using up most of the plant's energy supply. In addition, it showed an interest in improving productivity, reducing industrial waste, and cutting costs in order to ensure the timely delivery of large orders.

Analysis

| Table 8 | Initial Analysis Results for Parts Industry (1999) Co., Ltd.

No	Solution	Details	Adopted?
1	Improve bush heating process	Save energy and ensure consistent product quality by replacing old ovens	Y
2	Streamline air compressor operation	Save energy by optimizing performance of air compressors	Y
3	Manage wastewater	Reduce wastewater by enhancing product cleaning process	Y
4	Eliminate production inefficiencies caused by manual labor	Introduce automated system	Y
5	Reduce waste	Improve waste management methods	Y

As presented in <Table 8>, the ASEIC consulting team conducted an initial analysis and developed 5 solutions for Parts Industry (1999), Co., Ltd. These solutions were aimed at saving energy and reducing waste in accordance with the company's needs.

Expected Benefits

| Table 9 | In-depth Analysis Results for Parts Industry (1999) Co., Ltd.

No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Install barrier to prevent cutting oil from splattering	-	-	Yes
2	Install automatic expansion device for bushes	-	THB 90,000/year	Yes
3	Adopt induction heating	-	THB 1,800,000/year	Yes
4	Repair air compressors	1,482 kWh/year	THB 7,557/year	Yes
5	Adopt counter-current rinsing system	413 ㎥/year	THB 6,190/year	Yes
6	Add wastewater collection tank	-	-	Yes
Total	6	Energy savings: 1,482 kWh/year Water savings: 413 ㎥/year	THB 1,903,747/year	-

<Table 9> shows the expected benefits of the 6 solutions proposed to Parts Industry (1999) Co., Ltd. The 6 solutions obtained from the in-depth analysis included repairing air compressors and adopting induction heating. The team also recommended installing a barrier to prevent cutting oil from splattering, adopting counter-current rinsing, and adding a wastewater collection tank. If the company uses an automatic expansion device when manufacturing bushes, it can speed up production and reduce labor costs.

| Figure 19 | Confirmation of Implementation Plan

Eco-Innovation Consulting Project Implementation Plan

Company Name : Parts Industry (1999) Co., Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Closed system for covering cutting fluid	Yes	X		
2	Automatic machine for bush parts expansion	Yes		X	
3	Replace with induction heater	Yes			X
4	Maintain broken parts of air compressor	Yes	X		
5	Cascade rinsing system	Yes		X	
6	Wastewater catching basin	Yes		X	

※ Implementation Plan marked by long-term, mid-term and short-term

Above improvement items were obtained by Eco-Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the internal reviews

Person in Charge : Pongkith Wannwiriyarij

Date : 6 - 12 - 2016

Among the 6 solutions suggested by the ASEIC consulting team, the company has already implemented several measures including repairing air compressors. If the company converts to induction heating to produce bushes, it can also expect to see improvements in productivity and product consistency as well as a drop in energy consumption. Full implementation of the solutions will likely save the company 413㎥ of water and 1,482 kWh of energy per year, which corresponds to THB 1,903,747 per year.

Summary

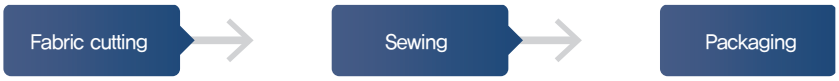
The consulting solutions mainly focused on saving energy and reducing waste to satisfy the most pressing needs of Parts Industry (1999) Co., Ltd. The company has implemented some of the suggested solutions and is planning to execute the rest after conducting feasibility tests. Out of the proposals that emerged from the in-depth analysis, adopting counter-current rinsing to reduce the amount of wastewater would be particularly applicable to any other businesses whose production process includes cleaning.

4.5.2 Vincita Co., Ltd.

Company Profile

Vincita Co., Ltd. was founded in 1987 as the first bicycle bag manufacturer in Southeast Asia. Half of its products are sold under its own brand and the other half as OEM products. The company manufactures mid to high quality products, targeting the European and Asian markets. It runs two assembly lines dedicated to making small and large products.

| Figure 20 | Production Process



The company's production process is simple, consisting of fabric cutting, sewing, and packaging. It has equipment for each process, but they are rarely used because they have issues in efficiency and precision. Plant managers thus prefer manual labor, which relies on the competency and skills of workers. But this manual approach prevents Vincita Co., Ltd. from establishing systematic production processes for each product, which the consulting team found was the company's biggest issue.

Current Issues and Consulting Needs

The company's main consulting need was to reduce waste generated in the production process. However, it was difficult to identify the exact amount of waste produced in each process because the company did not have clearly established assembly lines by product. The company did not know how much waste to reduce either, making it harder to set particular targets for waste reduction.

Analysis

| Table 10 | Initial Analysis Results for Vincita Co., Ltd.

No.	Solution	Details	Adopted?
1	Improve fabric cutting process	Vary cutting size by product	Y
2	Reduce waste of fabric	Mark cutting lines on fabric	Y
3	Identify amount of fabric needed in each process	Calculate input and output	Y
4	Reduce power waste	Prevent power consumption in non-work areas	Y
5	Reuse fabric	Reduce waste by reusing fabric	Y

As shown in <Table 10>, the ASEIC consulting team ran an initial analysis and proposed 5 solutions to Vincita Co., Ltd. that centered on waste reduction, the company's biggest area of interest.

Expected Benefits

| Table 11 | In-depth Analysis Results for Vincita Co., Ltd.

No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Introduce software for calculating fabric cutting size	-	-	Y
2	Precisely mark cutting lines on fabric	-	-	Y
3	Collect input and output data for each product	-	-	Y
4	Install high-efficiency lights	3,120 kWh/year	THB 12,480/year	Y
5	Reuse fabric scraps	-	-	Y
Total	5	Energy savings: 3,120 kWh/year	THB 12,480/year	-

After conducting the in-depth analysis, the ASEIC consulting team recommended 5 solutions as presented in <Table 11>. According to the company's needs, the team recommended solutions focused primarily on waste reduction. The team suggested collecting the input and output data of each product first and foremost in order to set a target amount for waste reduction. Other measures included employing a software program that calculates the cutting size for each product to prevent the waste of fabric, marking cutting lines on each fabric, and reusing fabric scraps left over from production. Installing high-efficiency such as LED lamps was also recommended to minimize power consumption in production facilities. As illustrated in <Table 11>, full implementation of the solutions is expected to save the company 3,120 kWh of energy per year, which corresponds to THB 12,480 per year. In addition, if the company uses the software, it will be able to increase its production efficiency as well as its daily production rate.

| Figure 21 | Confirmation of Implementation Plan

Eco-Innovation Consulting Project Implementation Plan

Company Name : Vincita Co., Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Software for calculating fabric cutting size	yes	/		
2	Design step of marking point	yes		/	
3	Collect in-out data for each process	yes			/
4	Replace with high efficiency lamp	yes		/	
5	Reuse remnant of cloth	yes		/	

※ Implementation Plan marked by long-term, mid-term and short-term

Above improvement items were obtained by Eco-Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the internal reviews

Person in Charge : Pasarapa Sinhaseni

Date : 3/11/16

Summary

Vincita Co., Ltd.'s main interest was in reducing the amount of waste in production facilities. Full implementation of the recommended solutions is expected to help the company achieve this goal successfully. Currently, it is not easy to determine attainable and target levels of waste reduction because the company lacks data on raw material inputs and production outputs in each process. However, as the company is committed to minimizing waste, it will likely continue to adopt more solutions and achieve substantial declines in waste in the future.

4.5.3 Wattanakit Footwear Ltd., Part.

Company Profile

Wattanakit Footwear Ltd., Part is a small manufacturer of shoes founded in 1976. The company has a keen interest in reducing waste generated during production.

| Figure 22 | Production Process

The company's production process is relatively simple and can be broken down into the following steps: material cutting, sewing, sole attaching, inspecting, and packaging. Most of these steps are performed manually by skillful workers because existing equipment have poor efficiency and accuracy.

Current Issues and Consulting Needs

It was clear that the company was most interested in minimizing waste in its production facilities. Since it relied heavily on the skills and experience of workers due to its small size, it also sought solutions to address potential decreases in efficiency and productivity entailed in manual labor.

Analysis

| Table 12 | Initial Analysis Results for Wattanakit Footwear Ltd., Part.

No.	Solution	Details	Adopted?
1	Improve material cutting process	Vary cutting size by product	Y
2	Reduce waste of material	Mark cutting lines on material	Y
3	Identify amount of material used in each process	Calculate input and output of materials	Y
4	Eliminate unnecessary power consumption	Prevent power consumption in non-work areas	Y
5	Reuse material	Reduce waste by reusing material	Y
6	Remove odor from old products	Prevent odor from seeping into shoe material	Y

As presented in <Table 12>, the ASEIC consulting team derived 6 solutions for Wattanakit Footwear Ltd., Part. as a result of the in-depth analysis and focused primarily on the reduction of waste.

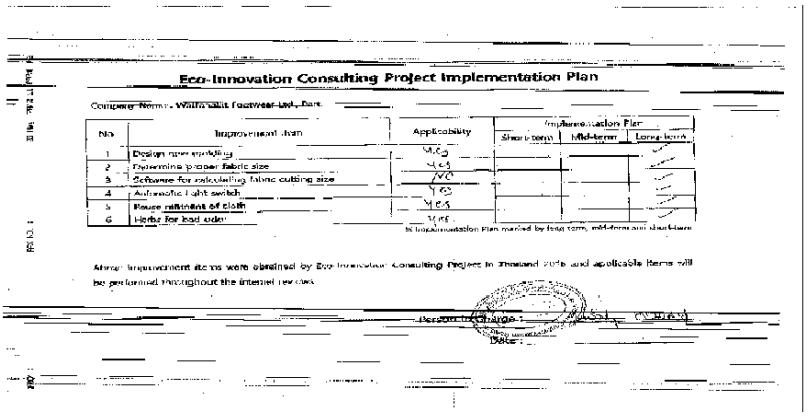
Expected Benefits

| Table 13 | In-depth Analysis Results for Wattanakit Footwear Ltd., Part.

No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Design new PVC injection mold	3 tons/year	THB 210,000/year	Y
2	Set proper size for cutting material	-	-	Y
3	Deploy software to calculate material cutting size	-	-	N
4	Install automatic lighting switch	121 kWh/year	THB 484/year	Y
5	Install high-efficiency lights	-	-	Y
6	Use herbs to prevent shoe odor			Y
Total	6	Raw material savings: 3 tons/year Energy savings: 121 kWh/year	THB 210,484/year	-

<Table 13> shows the final 6 recommendations made to Wattanakit Footwear Ltd., Part after the in-depth analysis. As presented above, 6 solutions are aimed at reducing waste. For setting the target amount of waste reduction, the consulting team suggested 3 solutions: designing a new PVC injection mold, setting a proper cutting size for every product, and deploying software to calculate cutting size by product to prevent the waste of material. The team also proposed installing automatic lighting switches in non-work areas and using high-efficiency lights such as LED lamps in order to save energy. Finally, placing herbs inside shoes was also recommended to deodorize products worn for a long time. Full implementation of the solutions proposed in <Table 13> is expected to save the company 3 tons of PVC and 3,120 kWh of energy per year, which corresponds to THB 210,484 per year. In addition, installing the aforementioned software is expected to improve production efficiency and further increase daily production rates.

| Figure 23 | Confirmation of Implementation Plan



Eco-Innovation Consulting Project Implementation Plan

No.	Improvement Item	Applicability	Implementation Plan: Short-term	Mid-term	Long-term
1	Design new products	Yes			
2	Determine proper fabric size	Yes			
3	Software for calculating fabric cutting size	Yes			
4	Automatic light switch	Yes			
5	Reuse remnant of cloth	Yes			
6	Herbs for bad odor	Yes			

Summary

Wattanakit Footwear Ltd., Part. focused its consulting services on reducing waste in production facilities. If all 6 proposed recommendations are implemented, the company will be able to achieve this goal successfully. In addition, using less PVC when manufacturing soles for shoes can help the company reduce the amount of industrial waste and lower costs as desired.

4.5.4 Grandis Industry Limited

Company Profile

Grandis Industry Limited was established in 1983 as an indoor furniture manufacturer. It produces furniture using particle board. Apart from conducting business in Thailand, it also exports products primarily to other Asian markets.

| Figure 24 | Production Process

As indicated in <Figure 24>, the company's production process involves coating particle boards with PVC or paper, cutting them, finishing the cut edges and assembling them together, and finally packaging. Among these processes, edging (i.e. heat treatment of cut edges) and air blowing to clean products consume the highest amount of energy. Another issue is that the sawdust produced from cutting particle boards hurts air quality inside the facilities and poses a health risk for workers.

Current Issues and Consulting Needs

The company's main areas of interest were reducing its energy consumption and waste production. In particular, it wished to cut down on the amount of electricity used in finishing the cut edges of particle boards, or edging, and cleaning product surfaces, both of which were energy-intensive processes. It was also seeking ways to minimize the amount of scrap particle board and sawdust produced while cutting semi-finished products. Lastly, it was concerned with deteriorating air quality inside the workplace due to dust generated during production and the effect that would have on the respiratory health of workers.

Analysis

| Table 14 | Initial Analysis Results for Grandis Industry Limited

No.	Solution	Details	Adopted?
1	Improve cutting of particle boards	Reduce waste with accurate cutting	Y
2	Optimize operating time of equipment	Save energy by adjusting number of times equipment is operated	Y
3	Change process layout	Rearrange layout to increase efficiency of workflow	Y
4	Streamline air compressor operation	Save energy by preventing leakage of compressed air	Y
5	Recycle waste	Reduce waste and impact on environment through recycling	Y
6	Develop eco-friendly products	Manage chemical content of products	Y

As shown in <Table 14>, the ASEIC consulting team conducted an initial analysis and developed a total of 6 solutions for Grandis Industry Limited. The solutions focused on reducing energy use and waste in line with the company's primary consulting needs.

Expected Benefits

| Table 15 | In-depth Analysis Results for Grandis Industry Limited

No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Cut particle boards using CNC machines	-	-	Y
2	Adjust number of times equipment is operated	-	-	Y
3	Change to U-shaped process layout	-	-	Y
4	Repair damaged part of air compressors	101,405 kWh/year	THB 443,520/year	Y
5	Reuse sawdust	-	-	Y
6	Use eco-friendly adhesives	-	-	Y
Total	6	Energy savings: 101,405 kWh/year	THB 443,520/year	-

The expected benefits of solutions proposed to Grandis Industry Limited are summarized in <Table 15>. As presented above, the 6 solutions developed from the in-depth analysis were aimed at decreasing energy consumption and waste to meet the most pressing needs of the company. For waste minimization, the consulting team recommended 2 solutions, namely, cutting particle boards with CNC machines and reusing sawdust. For saving energy, the team suggested adjusting the number of times the company operated its equipment and repairing damages in air compressors. The team also proposed adopting a U-shaped production line to improve workflow efficiency and using eco-friendly adhesives to prepare the company's products for green certification in the future. If the company implements all of the solutions in full, it is expected to save 101,405 kWh of energy per year, which corresponds to THB 443,520 per year.

| Figure 25 | Confirmation of Implementation Plan

Eco-Innovation Consulting Project Implementation Plan

Company Name : Grandis Industry Limited.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	CNC machine for cutting particle board	YES	✓		
2	Restrict the frequency of orders	YES		✓	
3	Improve flow process	YES		✓	
4	Seal leakage of air compressor	YES	✓		
5	Recycle sawdust	YES			✓
6	Eco-friendly glue	YES			✓

※ Implementation Plan marked by long-term, mid-term and short-term

Above improvement items were obtained by Eco-Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the internal reviews

Person in Charge : _____

Date : 14 - 11 - 2016

Summary

Adopting all solutions proposed by the ASEIC consulting team will help Grandis Industry Limited achieve its high-priority goals of minimizing energy consumption and waste. Also, recycling sawdust to produce wood pellets or other such materials can serve as an opportunity for the company to gain additional profit.

4.5.5 Yakiniku Giants (Thailand) Co., Ltd.

Company Profile

Established in 1998, Yakiniku Giants (Thailand) Co., Ltd. is a Japanese BBQ restaurant that has chains in many cities including Ayutthaya and Bangkok.

| Figure 26 | Production Process

As Yakiniku Giants (Thailand) Co., Ltd. is a BBQ restaurant, it does not have a separate production process. Rather, customers choose from a range of processed meats and grill the meats themselves.

Current Issues and Consulting Needs

The biggest concern of the company was saving energy. As cooking meat generated heat and raised the temperature inside the restaurant, it had to consume a significant amount of energy to cool the space. There was also the concern that the coal used in grills degraded indoor air quality and the dust it generated sometimes blocked the filters in ventilation ducts. To address these issues, the company had tried various measures like replacing ducts and having new grills made, but to little effect.

Analysis

| Table 16 | Initial Analysis Results for Yakiniku Giants (Thailand) Co., Ltd.

No.	Solution	Details	Adopted?
1	Streamline air conditioner operation	Improve control of indoor temperature to decrease consumption of cooling energy	Y
2	Streamline operation of external blower	Avoid overloading blower	Y
3	Repair external blower	Prevent leakage of cool air to save energy	Y
4	Improve lighting efficiency	Increase efficiency of lighting in main areas of restaurant to save energy	Y
5	Reduce water use	Introduce more efficient method of cleaning products and equipment	Y

As shown in <Table 16>, the ASEIC consulting team conducted an initial analysis and proposed a total of 5 solutions for Yakiniku Giants (Thailand) Co., Ltd. The solutions targeted energy conservation as it was the company's main area of interest.

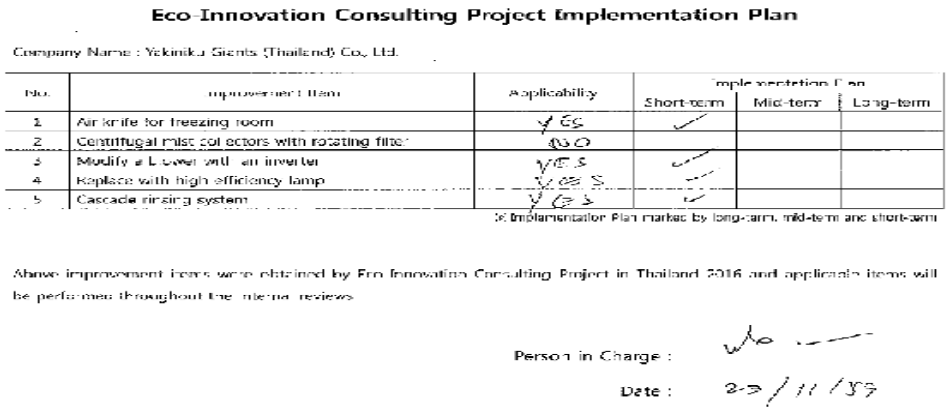
Expected Benefits

| Table 17 | In-depth Analysis Results for Yakiniku Giants (Thailand) Co., Ltd.

No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Install air knife above restaurant entrance	-	-	Y
2	Install centrifugal mist collector with rotating filter	-	-	N
3	Fit external blower with inverter	37,440 kWh/year	THB 187,199/year	Y
4	Replace existing lights with high-efficiency lighting	6,720 kWh/year	THB 26,880/year	Y
5	Adopt counter-current rinsing system	203 m3/year	THB 3,037/year	Y
Total	5	Energy savings: 44,160 kWh/year Water savings: 203 m3/year	THB 217,116/year	-

<Table 17> lists the expected benefits of the solutions developed for Yakiniku Giants (Thailand) Co., Ltd. As the table illustrates, the in-depth analysis yielded 5 solutions that centered on the company's biggest concern of saving energy. The team put forth various measures such as installing an air knife above the restaurant entrance, setting up a centrifugal mist collector with a rotating filter on the external blower, fitting the external blower with an inverter, replacing existing lights with high-efficiency lighting, and adopting the counter-current rinsing system to save water. Full implementation of these solutions is expected to save the company 44,160 kWh of energy and 203 m3 of water per year, which translates to annual economic savings of THB 217,116.

| Figure 27 | Confirmation of Implementation Plan



Eco-Innovation Consulting Project Implementation Plan

Company Name : Yakiniku Giants (Thailand) Co., Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Air knife for freezing room	Yes	✓		
2	Centrifugal mist collectors with rotating filter	No			
3	Modify & Blower with an inverter	Yes	✓		
4	Replace with high efficiency lamp	Yes	✓		
5	Cascade rinsing system	Yes	✓		

※ Implementation Plan marked by long-term, mid-term and short-term

Above improvement items were obtained by Eco Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the internal reviews

Person in Charge :

Date : 23/11/59

Summary

Having tested out a range of energy-saving measures in the past, Yakiniku Giants (Thailand) Co., Ltd.'s main interest was to identify better ways to achieve energy efficiency through the consulting program. It should be able to meet this goal by implementing all the solutions proposed by the ASEIC consulting team. Furthermore, this case study is anticipated to have positive ripple effects across similar businesses that cook food indoors and need energy-saving solutions to counter the high amount of heat generated during cooking. The water-efficient counter-current rinsing system would also be applicable to other industries that include rinsing in the production process.

4.5.6 Hanuman Food Supply Co., Ltd.

Company Profile

Hanuman Food Supply Co., Ltd. is a food processing company founded in 2010. It supplies processed meat to Yakiniku Giants (Thailand) Co., Ltd. as well as some greens and fruits, including kimchi and salads.

| Figure 28 | Production Process

The company's production process is very simple. It buys meats in bulk and keeps them refrigerated or frozen before cutting them into parts. As most of the meat processing is done manually, declines in production efficiency and productivity is a concern. Also, refrigerating and freezing meats to maintain their freshness require heavy energy consumption.

Current Issues and Consulting Needs

The consulting team found that the company's major concern was saving energy, given its high energy bills from using a considerable amount of electricity to maintain product freshness. The company was also seeking ways to boost productivity as most of its production process was manual. Finally, it was interested in reducing waste.

Analysis

| Table 18 | Initial Analysis Results for Hanuman Food Supply Co., Ltd.

No.	Solution	Details	Adopted?
1	Efficiently manage raw materials	Efficiently manage and use raw materials by reorganizing storage room	Y
2	Streamline operation of freezer room	Improve interior conditions of freezer room	Y
3	Increase energy efficiency of freezer room	Maintain temperature of freezer room by blocking inflow of relatively hotter outside air	Y
4	Replace existing lights with high-efficiency lighting	Prevent inefficient lighting from raising temperature and wasting energy	Y
5	Streamline air conditioner operation	Save energy by increasing efficiency of air conditioner	Y
6	Reduce water use	Introduce more efficient method of cleaning products and equipment	Y

As presented in <Table 18>, the ASEIC consulting team developed a total of 6 solutions for Hanuman as Food Supply Co., Ltd. as a result of the initial analysis. The solutions were geared toward energy reduction as it was the company's main area of interest.

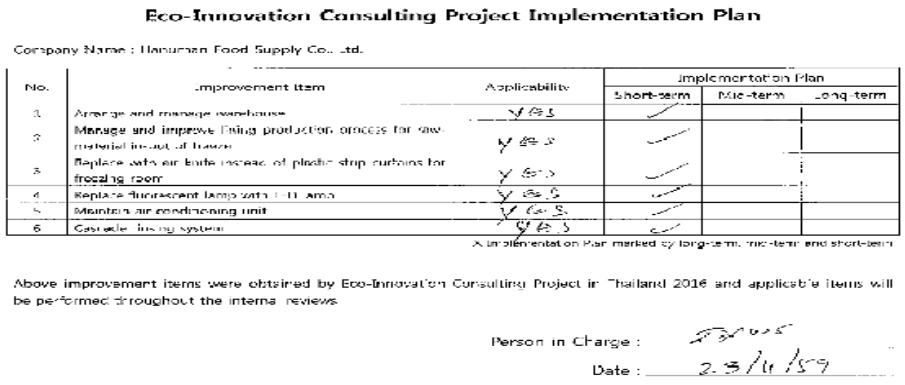
Expected Benefits

| Table 19 | In-depth Analysis Results for Hanuman Food Supply Co., Ltd

No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Reorganize storage of raw materials	-	-	Y
2	Improve method of transferring raw materials to freezer room	-	-	Y
3	Replace plastic curtain at freezer room entrance with air knife	-	-	Y
4	Replace existing lights with high-efficiency lighting	1,440 kWh/year	THB 5,760/year	Y
5	Conduct maintenance on air conditioner	-	-	Y
6	Adopt counter-current rinsing system	308 m3/year	THB 4,613/year	Y
Total	6	Energy savings: 1,440 kWh/year Water savings: 308 m3/year	THB 10,373/year	-

The expected benefits of solutions recommended to Hanuman Food Supply Co., Ltd. are outlined in <Table 19>. As the table shows, 6 solutions were derived from the in-depth analysis. They were directed at driving energy efficiency, the area in which the company needed the most consulting. In particular, the consulting team suggested changing the method of transferring raw materials to the freezing room, replacing the plastic curtain hanging at the entrance of the freezing room with an air knife, using efficient lighting, and conducting maintenance on the air conditioner. The team also proposed reorganizing the storage room to more efficiently use raw materials and reduce waste, and adopting the counter-current rinsing system to save water.
Full implementation of the solutions laid out in <Table 19> is expected to save the company 1,440 kWh of energy and 308 m3 of water per year, which corresponds to THB 10,373 per year.

| Figure 29 | Confirmation of Implementation Plan



Eco-Innovation Consulting Project Implementation Plan

Company Name : Hanuman Food Supply Co., Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Arrange and manage warehouse	Yes	✓		
2	Manage and improve filing production process for raw material in-out of freezer	Yes	✓		
3	Replace with air knife instead of plastic strip curtains for freezing room	Yes	✓		
4	Replace fluorescent lamp with T8 lamp	Yes	✓		
5	Maintain air conditioning unit	Yes	✓		
6	Cascade rinsing system	Yes	✓		

X Implementation Plan marked by long-term, mid-term and short-term

Above improvement items were obtained by Eco-Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the interna reviews

Person in Charge : [signature]

Date : 23/11/59

Summary

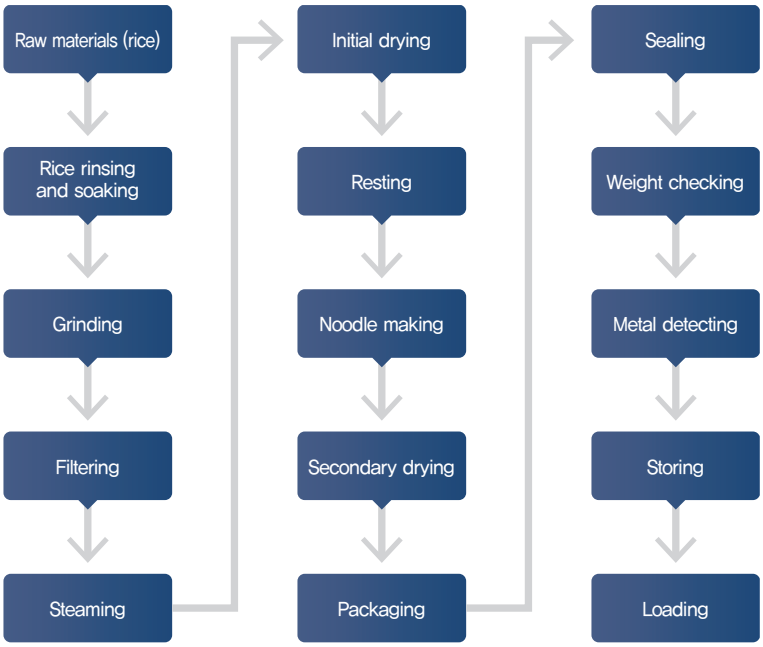
As a meat processing company, Hanuman Food Supply Co., Ltd. places great emphasis on maintaining product freshness and uses a significant amount of energy to that end. The company is therefore highly interested in achieving energy efficiency. It should be able to meet this goal when it implements the aforementioned solutions in full. In addition, counter-current rinsing, which was proposed to increase water efficiency, would be applicable to other industries that employ rinsing in their production process.

4.5.7 World Rice Pasta Co., Ltd.

Company Profile

Founded in 2010, World Rice Pasta Co., Ltd. manufactures dried organic rice noodles using eco-friendly ingredients.

| Figure 30 | Production Process



The production process consists of rinsing and soaking the raw materials (i.e. rice), grinding, filtering, steaming, initial drying, resting, noodle making, secondary drying, packaging, sealing, product weight checking, metal detecting, storing, and loading. Of these steps, grinding rice, initial drying, and drying the finished product requires the most amount of energy. Thus the consulting team focused on reducing the energy consumed during these three steps. The team also found that the company's old equipment experienced frequent failures.

Current Issues and Consulting Needs

World Rice Pasta Co., Ltd. was interested in saving energy and improving employee awareness about energy conservation. Drying was a necessary part of dried noodle production and required a lot of energy. In addition, the company was looking for overall improvements to its production facilities through the consulting project because the equipment was old and often needed repairing.

Analysis

| Table 20 | Initial Analysis Results for World Rice Pasta Co., Ltd.

No.	Solution	Details	Adopted?
1	Stabilize steam production	Create environment for consistent steam production	Y
2	Streamline steam production	Use optimal pressure required to produce steam	Y
3	Fix steam tanks	Improve thermal insulation of steam tanks	Y
4	Repair condenser tanks	Prevent heat loss during condensate recovery process	Y
5	Adjust amount of wood used	Combust minimum amount of wood required	Y

As presented in <Table 20>, the ASEIC consulting team ran an initial analysis and proposed a total of 5 solutions for World Rice Pasta Co., Ltd. The solutions were aimed at cutting production costs through energy conservation because that was the area the company was most interested in.

Expected Benefits

| Table 21 | In-depth Analysis Results for World Rice Pasta Co., Ltd.

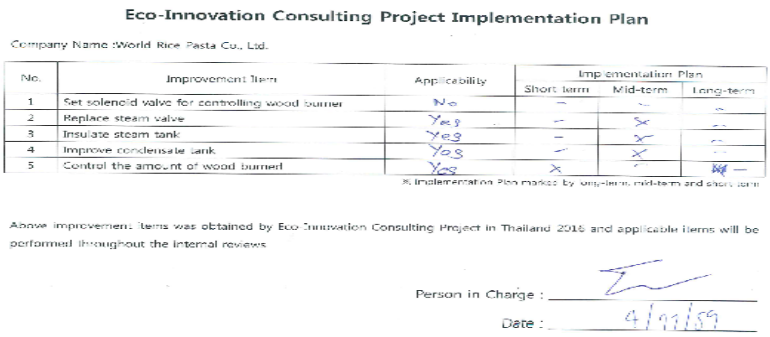
No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Install solenoid valves on wood boilers to stabilize steam production	791,337 MJ/year	-	N
2	Replace steam valves	57,600 MJ/year	-	Y
3	Improve thermal insulation of steam tanks	49,898 MJ/year	-	Y
4	Repair condenser tanks	113,216 MJ/year	-	Y
5	Adjust amount of wood used	-	-	Y
Total	5	Energy savings: 2,024,103 MJ/year	-	-

<Table 21> lists the expected benefits of the solutions developed for World Rice Pasta Co., Ltd. As shown in the table, the ASEIC consulting team presented 5 solutions that centered on conserving energy following the in-depth analysis. Specifically, the team proposed installing solenoid valves on wood boilers to produce a consistent amount of steam, replacing pressure-control valves to avoid producing more steam than necessary, improving the thermal insulation

of steam tanks, and repairing condenser tanks. The team also recommended the company to adjust the amount of wood it used to fire boilers so that it could decrease waste and mitigate its impact on the environment.

If World Rice Pasta Co., Ltd. executes all of these solutions, it is expected to save 2,024,103 MJ of energy per year, as highlighted in <Table 21>. As the wood used to fire boilers is procured internally, it is difficult to calculate the monetary value of these energy savings. It is, however, possible to estimate their impact on the environment: they correspond to 113,350 $kgCO_2$ less carbon dioxide emitted each year.

| Figure 31 | Confirmation of Implementation Plan



Eco-Innovation Consulting Project Implementation Plan

Company Name :World Rice Pasta Co., Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Set solenoid valve for controlling wood burner	No	–	–	–
2	Replace steam valve	Yes	–	X	–
3	Insulate steam tank	Yes	–	X	–
4	Improve condensate tank	Yes	–	X	–
5	Control the amount of wood burned	Yes	X	–	–

※ Implementation Plan marked by only short, mid-term and short term

Above improvement items was obtained by Eco-Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the internal reviews

Person in Charge :

Date : 4/11/59

Summary

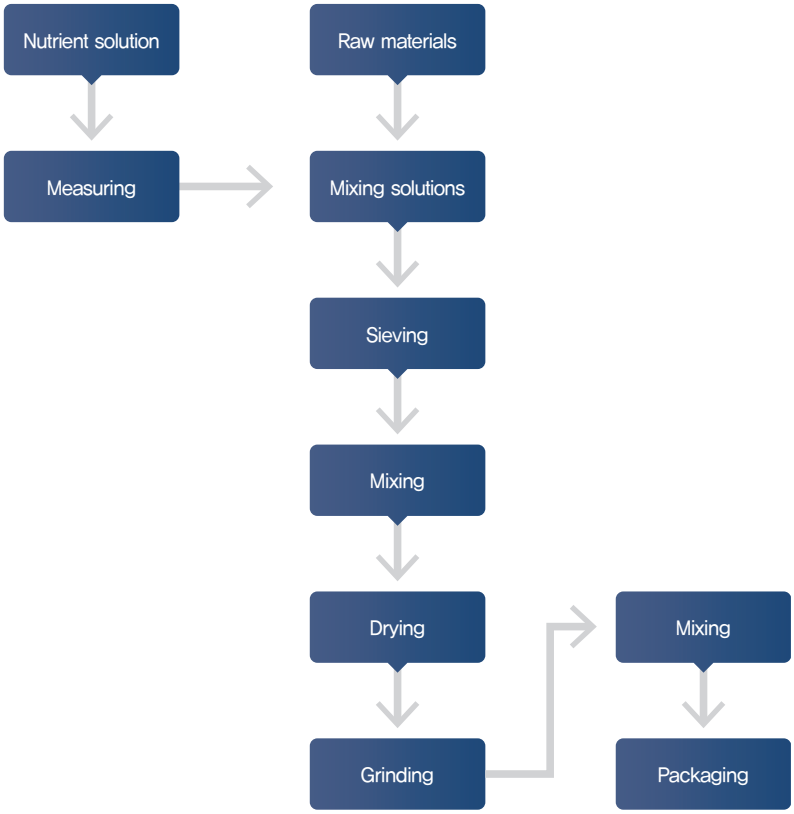
World Rice Pasta Co., Ltd. is most interested in saving energy during production. It should be able to achieve this goal by adopting all proposed solutions. As the ASEIC consulting team's visit identified issues in the production process and raised employee awareness about them, the team hopes to see the company carry on more initiatives to improve its production environment going forward.

4.5.8 Green Innovative Biotechnology Co., Ltd.

Company Profile

Green Innovative Biotechnology Co., Ltd. is an R&D-based manufacturer of plant and animal immunostimulants. It uses eco-friendly raw materials to produce immunostimulants in the form of powder or aqueous solutions.

| Figure 32 | Production Process



The production process largely involves measuring nutrient solutions, mixing solutions, sieving, mixing, drying, grinding, mixing, and packaging. For the aqueous solution version of the product, sieving, drying, and grinding are omitted. For the powder version, the solution derived from the mixing process is sprayed onto beans, the intermediate material, before the rest of the production steps are conducted. Accordingly, the company needs to reduce energy consumed in the steps following the spraying. The grinding process releases particles into the air, which represents a loss of raw materials and downgrades air quality inside production facilities.

Current Issues and Consulting Needs

The ASEIC consulting team found that using eco-friendly raw materials, which cost more than normal ingredients, put a significant amount of financial burden on Green Innovative Biotechnology Co., Ltd. The company also wished to minimize product loss and decrease energy use during the drying process. In addition, it expressed great interest in reducing the amount of fine particles generated during grinding, which is a part of the powdered product's production process, due to concerns of maintaining indoor air quality.

Analysis

| Table 22 | Initial Analysis Results for Green Innovative Biotechnology Co., Ltd.

No.	Solution	Details	Adopted?
1	Reduce raw material losses	Decrease waste by reusing raw materials	Y
2	Upgrade grinders	Improve efficiency of grinders	Y
3	Prevent energy loss while inputting raw materials	Add insulation to raw material receptacles	Y
4	Minimize energy loss during drying of fluids	Add insulation to fluid dryers	Y
5	Improve indoor air quality	Reduce dust emission	Y
6	Improve environmental friendliness of product	Reduce chemical content of raw materials	Y

As shown in <Table 22>, the ASEIC consulting team conducted an initial analysis and developed 6 solutions for Green Innovative Biotechnology Co., Ltd, with the aim of reducing raw materials, energy, and waste based on its consulting needs.

Expected Benefits

| Table 23 | In-depth Analysis Results for Green Innovative Biotechnology Co., Ltd.

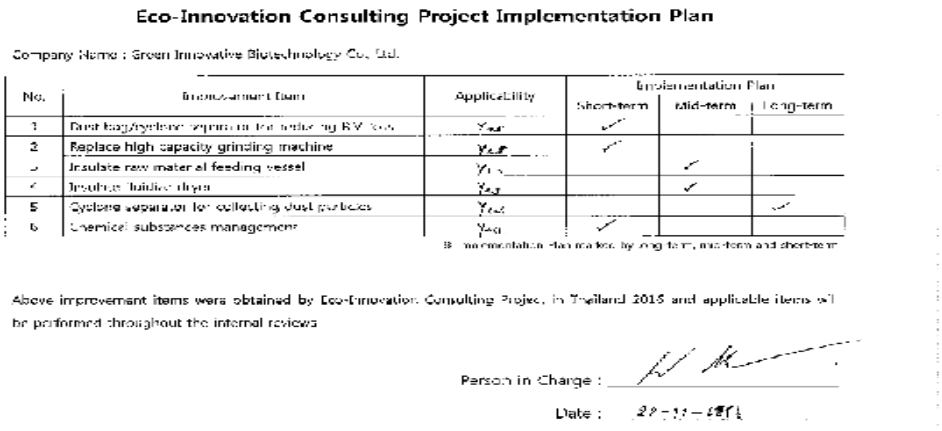
No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Reduce raw material losses with dust bags and dust separators	3,600 kg/year	THB 1,800,000/year	Y
2	Use high-efficiency grinders	-	THB 60,000/year	Y
3	Add insulation to raw material receptacles	4,080 kWh/year	THB 21,000/year	Y
4	Add insulation to fluid dryers	-	-	Y
5	Install dust separators to collect dust	-	-	Y
6	Manage chemical content of products	-	-	Y
Total	6	Raw material savings: 3,600 kg/year Energy savings: 4,080 kWh/year	THB 1,881,100/year	-

The expected benefits of solutions recommended to Green Innovative Biotechnology Co., Ltd. are outlined in <Table 23>. As presented above, the ASEIC consulting team developed 6 solutions from the in-depth analysis. This included addressing the company's greatest consulting need, which was to increase the efficiency of raw material usage via dust collection. The team

also proposed replacing existing grinders with high-efficiency ones and adding insulation to raw material receptacles and fluid dryers in order to save energy. In addition, the team suggested installing dust separators to collect dust and increase indoor air quality as well as managing the chemical content of products to improve their environmental friendliness.

Out of the 6 solutions proposed by the team, the company responded most favorably to deploying dust collection technology to use raw materials more efficiently. Currently, it is collecting data on cyclone sizes and other information needed to build a cyclone separator customized to its production needs. As <Table 23> shows, full implementation of the solutions is expected to save the company 3,600 kg of raw materials and 4,080 kWh of energy per year, which translates to THB 1,881,100 per year.

| Figure 33 | Confirmation of Implementation Plan



Eco-Innovation Consulting Project Implementation Plan

Company Name : Green Innovative Biotechnology Co. Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Dust bag/cyclone separator for collecting RM loss	Yes	✓		
2	Replace high capacity grinding machine	Yes	✓		
3	Insulate raw material feeding vessel	Yes		✓	
4	Insulate fluidize dryer	Yes		✓	
5	Cyclone separator for collecting dust particles	Yes			✓
6	Chemical substances management	Yes	✓		

※ Implementation item is to be by long term, mid-term and short-term

Above improvement items were obtained by Eco-Innovation Consulting Project in Thailand 2015 and applicable items will be performed throughout the internal reviews

Person in Charge : _____

Date : 27-11-2015

Summary

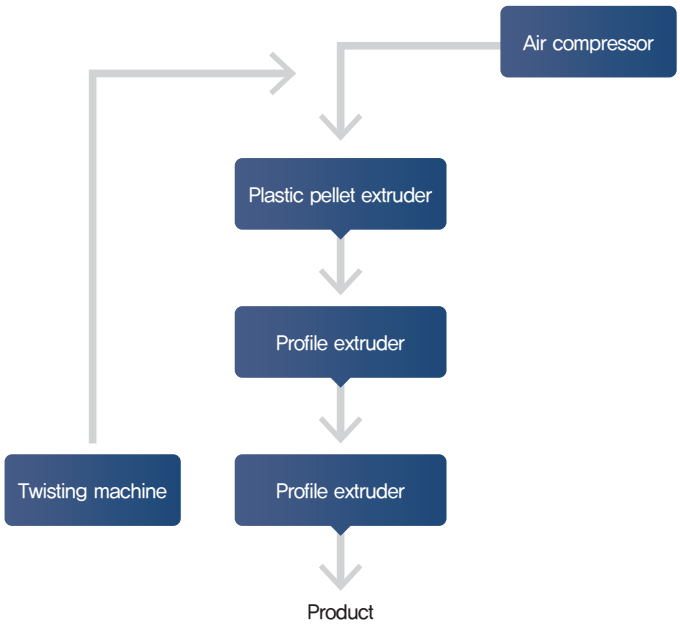
Green Innovative Biotechnology Co., Ltd. is planning solution implementation with more enthusiasm than any other company participating in the project. If it executes all solutions, it should be able to achieve its goal of saving energy and raw materials. Installing dust separators to collect dust and minimize raw material loss would also be an applicable solution to any business that generates powder or dust particles during production. Moreover, this case study can be useful to companies that feel a need to install dust separators but are experiencing difficulties due to lack of information.

4.5.9 M.B.J. Enterprise Co., LTD

Company Profile

Founded in 1995, MBJ Enterprise Co., LTD mainly produces color masterbatches and wood-plastic composite profiles.

| Figure 34 | Production Process



The production process consists of mixing powders, extruding plastic pellets, producing profiles, and packaging. As extruding pellets and producing profiles are especially energy-intensive, these processes need higher energy efficiency. In addition, using powdery raw materials hurts indoor air quality and employee health.

Current Issues and Consulting Needs

The consulting team discovered that a large portion of MBJ Enterprise Co., LTD's production process was already automated. However, the company was highly interested in saving energy because extruding pellets and using those pellets to produce profiles consumed a large amount of energy. It hoped to benefit from the consulting project given that it was planning to relocate its production facilities early in 2017. Moreover, it aimed to improve production processes, increase productivity, and raise employee awareness.

Analysis

| Table 24 | Initial Analysis Results for MBJ Enterprise Co., LTD

No.	Solution	Details	Adopted?
1	Streamline air compressor operation	Save energy by operating only when necessary	Y
2	Reduce energy consumed by air compressors	Save energy by maintaining optimal temperatures when operating air compressors	Y
3	Use high-efficiency air compressors	Improve efficiency of air compressors	Y
4	Increase efficiency of cooling equipment	Save energy by increasing cooling efficiency	Y
5	Improve indoor air quality	Reduce dust emissions	Y

As presented in <Table 24>, the ASEIC consulting team developed a total of 5 solutions for M.B.J. Enterprise Co., LTD as a result of the initial analysis. The team concentrated on creating energy-saving measures to meet the company's most pressing consulting need.

Expected Benefits

| Table 25 | In-depth Analysis Results for MBJ Enterprise Co., LTD

No.	Solution	Expected Benefit		Adopted?
		Estimated Savings	Economic Benefit	
1	Use automatic control device for air compressors	70,200 kWh/year	THB 288,800/year	N
2	Install hot water discharge pipe on air compressors	9,335 kWh/year	THB 37,340/year	N
3	Install new air compressors	-	-	Y
4	Install ozone generator in cooling equipment to increase cooling efficiency	-	-	N
5	Install dust separators to collect dust	-	-	Y
Total	5건	Energy savings: 79,535 kWh/year	THB 318,140/year	-

<Table 25> outlines the expected benefits of solutions proposed to MBJ Enterprise Co., LTD. As the table illustrates, the in-depth analysis yielded 5 solutions that addressed the company's top priority of saving energy. The ASEIC consulting team recommended 3 solutions pertaining air

compressors: adding automatic control devices, installing hot air discharge pipes, and replacing old air compressors. The team also proposed installing ozone generators in cooling equipment to boost cooling efficiency and setting up dust separators to collect dust and improve indoor air quality. If the company takes all of the consulting team's suggestions, it is expected to save 79,535 kWh of energy per year, which translates to THB 318,140 per year, as shown in <Table 25>.

| Figure 35 | Confirmation of Implementation Plan

Eco-Innovation Consulting Project Implementation Plan

Company Name : M.B.J. Enterprise Co., Ltd.

No.	Improvement Item	Applicability	Implementation Plan		
			Short-term	Mid-term	Long-term
1	Automatic controller in compressor	NO			
2	Hydrothermal vent at the compressor	NO			
3	Install new compressor	YES			X
4	Ozone generator system to cooling efficiency	NO			
5	Cyclone separator for collect dust particles	YES			X

※ Implementation Plan marked by long-term, mid-term and short-term

Above improvement items were obtained by Eco Innovation Consulting Project in Thailand 2016 and applicable items will be performed throughout the internal reviews

Person in Charge : [illegible]

Date : 5/11/2560

Summary

M.B.J. Enterprise Co., LTD is most interested in minimizing the amount of energy consumed by its production facilities. It will likely meet this objective by adopting all of the above solutions. However, due to some internal issues with the facilities, the company appears to be able to implement only a portion of the solutions. Yet adopting even a few of the solutions is expected to save the company a notable amount of energy. In addition, installing dust separators to collect dust is a solution that many business generating powder or dust particles during production can benefit from. Moreover, this case study is anticipated to serve as a good example to companies that wish to install dust separators but are experiencing difficulties because they lack the necessary information.

6 Follow-up

This was the first year that the Eco-Innovation Consulting Project was conducted in Thailand. The ASEIC consulting team developed a wide range of solutions for SMEs in Thailand, yet it faced a number of limitations in executing them. While the team took into account the participating companies' major areas of interest and business situation in developing the solutions, the companies ended up implementing only 46% of them due to the entailed investment costs and insufficient information on their technical feasibility. Accordingly, the project's economic and environmental benefits were concentrated on the companies that adopted solutions expected to be particularly effective.

One way to address this issue is to perform, in tandem with the consulting, tests or research on the solutions to prove their feasibility. This will help build confidence in the effectiveness of the solutions and persuade companies to invest. A prime example is how some participating companies are collaborating with NSTDA to conduct tests on deploying dust collection systems, as featured in the project's success stories.

Moreover, if the companies are continuously provided information on and connected to SME support programs by the Thai government and external funding opportunities, even those that are reluctant to invest in their production facilities will be more willing to participate in Eco-Innovation activities.

Such systematic follow-up measures are needed to deliver tangible improvements to the companies as a result of the consulting. This will in turn contribute to building a sustainable society, which lies at the heart of Eco-Innovation initiatives.

Appendix

1. Final Results by Company

2. Application Forms by Company

3. Consulting Satisfaction Survey

4. Eco-innovation Awareness Improvement Survey

ASEM
SMEs
Eco-Innovation
Center

E-2FL, Pangyo Innovalley, 255, Pangyo-ro, Bundang-gu,
Seongnam-si, Gyeonggi-do, Repulic of Korea

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