Project Efficiency Assessment for Eco-Industrial Area

Methavee Siangrai, Ratchaphong Klinsrisuk and Allan Sriratana Tabucanon*

Faculty of Environment and Resource Studies, Mahidol University, Nakhon Pathom 73170, Thailand

ABSTRACT

This study evaluates efficiency of the developed eco-industrial area project by applying a principle of costs and benefits. The objective is to compare costs and benefits between establishment of eco-industrial area and typical industrial one. Therefore, this study investigates the project costs from construction, maintenance, and operation in both fixed and variable costs. Furthermore, valuation of direct returns from income and indirect benefits from the development of eco-industrial area project were also conducted, based on the technique of experimental behavior or Choice Experiment to estimate the willingness to pay of factories in the projects. Finally, the results were compared with costs and all benefits to calculate the efficiency of the developed eco-industrial area project to support investment decision. The results of this research are intended to incentivize developers to choose to invest in an eco-industrial area project. A method was developed to analyze indirect benefits through questionnaires, such as a willingness to pay to maintain environmental quality. The value of the indirect benefits of developing the eco-industrial area per year equals 148,965,380.64 baht when combined with the direct returns of the eco-industrial area project and comparing costs-benefits. Cost analysis found that the Eco-Industrial Area Project has a net profit equal to 25,948,470,863.00 baht and has a payback period of 2.82 years, which shows that it is a fast payback period, which is very attractive for investment because the payback period of an industrial park/zone is approximately 3.27 years. Which is derived from comparing the development costs of the project with the direct benefits calculated as profit. However, suppose the development is in the form of eco-industrial areas. In that case, there will be additional indirect benefits that can be assessed from the willingness of factory operators to pay for the value of investments in environmentally-friendly industrial areas. This results in a faster return on investment and may meet the demand from many factory operators in the current era who have a positive attitude towards maintaining environmental quality, coexisting peacefully with communities, reducing pollution and impacts that could lead to conflicts, and potentially enhancing economic competitiveness..

Keyword: Eco-Industrial/ Willingness to Pay/ Environment

1. INTRODUCTION

Industry is a business sector that is developing globally, including in Thailand. Economic prosperity contributes to the advancement of countries, leading them towards developed status. Therefore, many developing nations emphasize industrial development to foster economic growth, which can impact society and the environment.

Thailand has set development directions to ensure sustainable and prosperous development in line with national aspirations based on the principles and concepts of the 4 principles, namely: Sufficiency Economy Philosophy, Building Resilience, Sustainable Development Goals of the United Nations, which aim not to leave anyone behind, and the concept of bioeconomy development, circular economy, and green economy as outlined in the National Economic and Social Development Plan (13th Edition, B.E. 2566-2570). The Ministry of Industry and the Industrial Estate Authority of Thailand have collaborated to promote the establishment of eco-industrial estates or eco-industrial towns to achieve sustainable, balanced development in the economy, society, and environment

Currently, some developers are implementing eco-industrial developments. However, there are still many developers who are in the process of considering decisions to develop their projects in an environmentally friendly direction. Researchers identify cost issues in developing eco-industries, which may require investment in advanced waste treatment systems to prevent pollution.

Reducing pollution to preserve environmental quality, such as water and air quality, will benefit developers and factory operators by reducing costs associated with health care, health insurance funds, or compensation for workers and surrounding communities.

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

Moreover, they enhance community satisfaction by addressing environmental quality concerns, potentially meeting requirements set by the Industrial Estate Authority of Thailand for eco-industrial development, which mandates the establishment of waste management centers to recycle industrial waste within industrial estates. This approach reduces pollution and waste disposal costs. Developing projects under environmentally friendly conditions can also create satisfaction among local residents and global markets, potentially increasing land value or the value of eco-friendly products and services from developers and factory operators alike.

Researchers recognize the importance of developing environmentally sustainable industries and are committed to conducting this research. The goal is to demonstrate to project developers the significant returns and the willingness of businesses to invest in maintaining a good environment. This will show developers the value communities place on investments made for industrial development in an environmentally friendly direction. This is part of sustainable industrial sector development based on economic, social, and environmental balance, aligning with Thailand's journey towards Thailand 4.0.

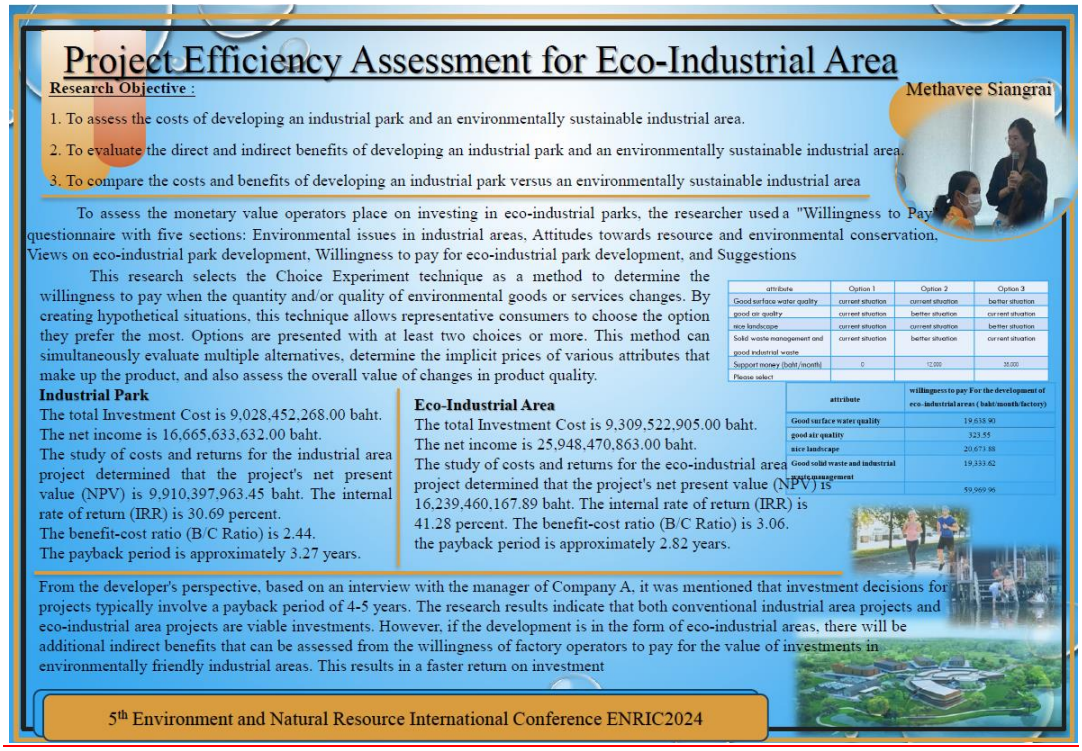

Figure 1. Poster of ENRIC conference

2. METHODOLOGY

2.1 Research tools

To assess the monetary value operators place on investing in eco-industrial parks, the researcher used a "Willingness to Pay" questionnaire with five sections: Environmental issues in industrial areas, Attitudes towards resource and environmental conservation, Views on eco-industrial park development, Willingness to pay for eco-industrial park development, and Suggestions

This research selects the Choice Experiment technique as a method to determine the willingness to pay when the quantity and/or quality of environmental goods or services changes. By creating hypothetical situations, this technique allows representative consumers to choose the option they prefer the most. Options are presented with at least two choices or more. This method can simultaneously evaluate multiple alternatives, determine the implicit prices of various attributes that make up the product, and also assess the overall value of changes in product quality.

The Choice Experiment technique is used to determine willingness to pay or willingness to accept compensation when the quantity and/or quality of environmental goods or services changes. By creating hypothetical situations, this technique allows representative consumers to choose the option they prefer

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

the most, with at least two options presented. This method can evaluate multiple alternatives simultaneously, determine the implicit prices of various attributes that make up the product, and assess the overall value of changes in product quality.

2.2 Data preparation

Study the basic information of industrial park projects, industrial estate projects, and industrial zone projects from Company A, a leading company in developing industrial areas. This involves examining the costs of designing infrastructure for these projects by interviewing project managers of industrial park projects, industrial estate projects, and industrial zone projects to determine the cost of expenses involved in developing different types of projects.

Study secondary data, including the regulations of the Industrial Estate Authority of Thailand (IEAT) concerning the standards for infrastructure systems, facilities, and services for eco-industrial estates as outlined in the 2014 regulations and the framework for developing eco-industrial cities provided by IEAT and the Department of Industrial Works. Review relevant research both in Thailand and internationally to establish criteria for designing eco-industrial park projects. Additionally, investigate the central cost pricing by conducting focus group interviews with operators in an industrial park in Ayutthaya province, finding that acceptable central cost prices are 6,000 / 12,000 / 35,000 / 200,000 THB per month. The acceptable central cost prices are derived from the amounts previously paid by factory operators for managing common areas or paid to developers for general management of the common areas in the project.

Study the target industrial groups in Ayutthaya Province and conduct simple random sampling by drawing lots to select factories in an industrial park project as representatives of the industrial sector for the questionnaire. The Industrial Park in Ayutthaya was chosen because it comprises a diverse range of factories that have been operating for an extended period. These factories have extensive experience in operating within industrial parks, industrial estates, and industrial zones, making them suitable representatives for this study.

Study the characteristics of eco-industrial cities by reviewing the literature on eco-industrial cities both domestically and internationally. Compare the similarities and differences among various research works to identify characteristics other researchers agree upon as indicative of an eco-industrial city. The researcher then compared the summarized characteristics of eco-industrial cities with the development framework for eco-industrial city in Thailand. This comparison was made against the basic design data from Company A to identify which investments align with the characteristics of an eco-industrial city. It was found that there are four characteristics for which Company A has made investments in their eco-industrial park projects. The researcher chose these four characteristics to evaluate indirect returns by assessing the willingness to pay. This approach aims to obtain a total of the ecological returns and compare it with the ecological investments made by Company A. Finally, and this comparison will be used to assess the cost-effectiveness of developing eco-industrial park projects and determine whether the investment is worthwhile and attractive.

The characteristics selected for evaluating the willingness to pay for the development of eco-industrial areas by factory operators include:

1. Quality of Surface Water Sources
2. Air Quality
3. Landscape or Green Spaces
4. Management of Waste and Industrial By-products

These four characteristics are those for which costs are controlled and allocated in the operation of Company A's industrial area projects.

2.3 Data collection

Design the questionnaire

Based on the experience of developing an eco-industrial park project, the characteristics indicative of the development of eco-industrial areas were identified as a total of four key characteristics. The researcher then established two levels of change for these characteristics environmental quality to assess willingness to receive compensation.

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

Attribute	Level
Surface water quality	current situation
	better situation
Air quality	current situation
	better situation
Landscape features	current situation
	better situation
Solid waste and industrial waste management	current situation
	better situation
Common fee (baht/month)	0/ 6,000 / 12,000/ 35,000 / 200,000

Therefore, according to Full Factorial Design, there would be a total of 2*2*2*2*5 = 80 options. This method results in a large number of options. In this study, the Orthogonal Design command in IBM SPSS Statistics 26 will be used to select independent possibilities and to ensure a manageable number of choices. Similar to the study by Udomsak Silpachavanich (2013) [1], which found a total of 16 options, this approach simplifies the questionnaire for interviewees. Thus, the set of options will be divided into 4 equal groups, resulting in 4 different questionnaire formats.

Card List							Group
	Card ID	Water	Air	Landscape	Waste	Price	
1	1	current	better	Current	better	12,000	1
2	2	better	Current	better	Current	200,000	
3	3	current	better	better	Current	12,000	
4	4	current	better	Current	better	200,000	
5	5	current	better	better	Current	6,000	2
6	6	better	better	better	better	0	
7	7	current	Current	Current	Current	6,000	
8	8	better	Current	better	Current	12,000	
9	9	better	better	Current	Current	35,000	3
10	10	better	Current	Current	better	6,000	
11	11	current	Current	Current	Current	0	
12	12	better	better	Current	Current	0	
13	13	better	better	better	better	6,000	4
14	14	current	Current	better	better	0	
15	15	current	Current	better	better	35,000	
16	16	better	Current	Current	better	12,000	

Next, the choice sets for each questionnaire format will be created using the Cyclical Design method. In this approach:

- Option 1 will be set at the current level.

Option 2 and Option 3 will reflect improvements in the situation.

- Option 2 will be derived from Row 1 of Table 3.3.1-3.
- Option 3 will build on Option 2 by increasing the level of each characteristic. When the highest level is reached, the sequence will restart from the lowest level.

This methodology is similar to that used by Areeyapat Petchrat (2016) in the academic work on willingness to pay for biodiversity benefits and ecosystem services, with a case study in Bang Krajao, Phra Pradaeng District, Samut Prakan Province. [2]

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

Attribute	Option 1	Option 2	Option 3
Good surface water quality	current situation	current situation	better situation
good air quality	current situation	better situation	current situation
nice landscape	current situation	current situation	better situation
Solid waste management and good industrial waste	current situation	better situation	current situation
Support money (baht/month)	0	12,000	35,000
Please select			

To evaluate the validity of the developed questionnaire, it will be reviewed by 5 experts (Item Objective Congruence (IOC))

Next, to determine the sample size, using the Yamane formula (1970), it was found that this research requires a total of 137 samples from a population of 207 factories. The sample of 137 factories will be selected using simple random sampling by drawing lots. This will ensure that each factory has an equal chance of being selected and that the sample is representative of the population.

2.4 Data analysis

2.4.1 Cost analysis

Study the costs of developing an industrial eco-park by Company A, including fixed and variable costs. These costs comprise land costs, construction of infrastructure systems, operational costs, and maintenance costs. The costs have been collected from market prices and estimates from the developer and converted into the required quantities of work. By summing up the costs for each construction item and development, you can estimate the total cost of developing the industrial area and eco-industrial park.

The work volume used in this cost calculation is based on the area where companies or respondents have established their factories, specifically in the industrial area of Company A located in Uthai, Phra Nakhon Si Ayutthaya. Calculate the total cost by summing the unit price multiplied by the quantity for fixed costs (TFC) and variable costs (TVC), yielding the overall total cost (TC). This represents the cost of developing an industrial area as either an industrial park or an industrial estate.

For this research, the goal is to compare the costs and benefits of developing an eco-industrial area to provide developers with motivation to choose eco-industrial development. Therefore, the costs associated with the four identified attributes are separated: water quality, air quality, landscaping, and waste management. These are the attributes defined for developing an eco-industrial area in this study. The costs are then calculated and added to the total cost and benefits of developing the eco-industrial area.

2.4.2 Return analysis

Direct return: Analysis involves calculating revenue from the direct sale of industrial land developed by the project. The analysis includes; Total Revenue (TR): The total amount of money received from sales., Net Return (NR): The difference between total revenue and total variable costs., and Net Profit (NP): The difference between total revenue and total costs. Net profit indicates the company's profitability.

Indirect return: Indirect Return Analysis evaluates the indirect benefits or value through a willingness-to-pay approach. This involves direct questioning of individuals regarding the value they place on environmental preservation to maintain ecosystem services. The Choice Experiment (CE) technique is used, where individuals select the option they prefer most from various scenarios to assess their willingness to pay. The willingness-to-pay questionnaire in this study consists of five sections but is analyzed in two groups: general data not related to willingness to pay and data specifically related to willingness to pay. General data are analyzed using IBM SPSS Statistics 26 to calculate means and percentages. For the willingness-to-pay data, multinomial logistic regression is applied using IBM SPSS Statistics 26.

To assist developers in investment decisions, it's essential to assess the value of the investment by comparing the returns against the costs, known as Cost-Benefit Analysis. This involves evaluating the following: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost Ratio (B/C Ratio), and Payback Period.

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

3. RESULTS AND DISCUSSION

3.1 Development of industrial area projects

Total Area: Approximately 11,120.50 acres were developed, with approximately 8,400 rai available for sale. Infrastructure Development: The project included major public utility systems: 84,000 cubic meters per day for water supply, and 67,200 cubic meters per day for wastewater treatment. The total investment cost is 9,028,452,268.00 baht.

- Investment Phases: The investment was phased over three years:
  - Year 0: Initial investment in land purchase and land improvement, and development of 60% of the total infrastructure cost.
  - Year 1: Additional investment in infrastructure development covering 30% of the total cost.
  - Year 2: Additional investment covering the remaining 10% of the infrastructure cost.
- Operating Expenses: After the industrial area is operational:
  - Central maintenance costs 500 Baht.
  - Water production costs 17.50 Baht per cubic meter.
  - Wastewater treatment costs 4.50 Baht per cubic meter.
- Annual Costs: Vary each year, particularly higher during the first two years due to ongoing development activities until completion in Year 3. From Year 3 to Year 7, costs mainly involve operational expenses.
- The development costs for the industrial area project over the specified years:
  - Year 0: 8,110,114,616.00 Baht
  - Year 1: 723,619,538.00 Baht
  - Year 2: 334,183,313.00 Baht
  - Year 3: 209,197,888.00 Baht
  - Year 4: 348,663,000.00 Baht
  - Year 5: 488,128,200.00 Baht
  - Year 6: 662,459,700.00 Baht
  - Year 7: 697,326,000.00 Baht

The return on investment from industrial area development includes income from land sales, central service fees, revenue from industrial water sales, and revenue from industrial wastewater treatment by entrepreneurs. The total income is 28,239,325,800.00 baht, which will increase according to the number of units sold each year. Income will begin in year 1 after the industrial area is developed and ready for sale.

The revenues generated from the industrial area development project over the specified years:

- Year 1: 1,301,634,600.00 Baht
- Year 2: 2,644,903,800.00 Baht
- Year 3: 4,029,807,600.00 Baht
- Year 4: 5,456,346,000.00 Baht
- Year 5: 5,622,884,400.00 Baht
- Year 6: 7,091,057,400.00 Baht
- Year 7: 2,092,692,000.00 Baht

After deducting all the total costs incurred, the net income is 16,665,633,632.00 Baht. This represents the profit generated from the project after subtracting all expenses from the total revenue over the specified years

3.2 Development of eco-industrial area projects

The development of the eco-industrial project area covers approximately 11,120.5 acres, following the concept of Eco-Industrial development. The design incorporates green spaces and eco-belts surrounding the project area. Treated wastewater is recycled within the project to improve quality, reducing wastewater discharge outside the project area by 15%. This investment aims to preserve environmental quality, particularly surface water sources.

In addition to investing in quality surface water sources, the costs of developing this eco-industrial area include continuous air quality monitoring and establishing systems to collect data on air pollutants. Investments are also made in landscaping to enhance aesthetics and green spaces. Proper management of industrial waste, including setting up an industrial waste exchange center within the

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

project to facilitate exchanges among factories, is another aspect of the investment. Overall, the total cost of developing the project amounts to 9,309,522,905.00 baht.

The project's investment is divided over three years as follows:

Year 0: It begins with purchasing and improving all the land and initiating 60% of the total public infrastructure development cost.

Year 1: Invests an additional 30% in public infrastructure development.

Year 2: Contributes the remaining 10% to complete the public infrastructure development.

After the industrial area opens for operation, ongoing operational costs include:

- Central maintenance fee: 1,000 baht/factory
- Production cost of tap water: 17.50 baht per cubic meter
- Production cost of RO water: 20 baht per cubic meter
- Wastewater treatment cost: 5.50 baht per cubic meter

Thus, initial operational expenses start in Year 1, continue through Year 2, and continue until Year 7, following the completion of the public infrastructure construction. After Year 7, only operational expenses will continue, resulting in fluctuating annual investment costs.

The development costs for the eco-industrial area project over the specified years:

- Year 0: 8,278,756,998.97 baht
- Year 1: 811,073,930.00 baht
- Year 2: 416,429,049.00 baht
- Year 3: 295,105,608.00 baht
- Year 4: 447,103,608.00 baht
- Year 5: 621,471,144.00 baht
- Year 6: 833,838,180.00 baht
- Year 7: 871,837,680.00 baht

The return on investment from developing eco-industrial areas includes income from land sales, central service fees, revenue from industrial water sales, and revenue from industrial wastewater treatment by entrepreneurs. In addition, there are environmental compensation payments and hidden price increases from additional investments in environmental aspects, totaling 11,733.97 baht per rai (for Total Projects Area approximately 11,120.50 rai: 19,638.90 baht/month/factory for good surface water quality, 323.55 baht/month/factory for good air quality, 20,673.88 baht/month/factory for nice landscape, 19,333.62 baht/month/factory for good solid waste and industrial waste management), resulting in a total income of 38,524,087.06 baht. Income will increase with the number of units sold increasing annually, starting with income in year 1 after the development of eco-industrial areas is completed and ready for sale.

The annual revenues for the first 7 years are as follows:

- Year 1: 1,731,578,100.00 baht
- Year 2: 3,570,658,140.00 baht
- Year 3: 5,433,354,360.00 baht
- Year 4: 7,319,666,760.00 baht
- Year 5: 7,553,941,080.00 baht
- Year 6: 9,519,793,500.00 baht
- Year 7: 2,851,371,600.00 baht

After deducting total costs, the net income amounts to 25,948,470,863.00 baht.

This phased approach and detailed cost breakdown allow developers to effectively manage and forecast expenses associated with eco-industrial park development.

3.3 Cost and return on investment comparison of projects

One of the objectives of this research is to illustrate the project's performance evaluation by comparing costs and benefits. The researcher interviewed the manager of Company A regarding their project development plans. It was found that Company A plans to develop the project by dividing the investment and setting a 7-year sales plan. This approach results in varying annual costs, operational expenses, and returns.

The study of costs and returns for the industrial area project determined that the project's net present value (NPV) is 9,910,397,963.45 baht. The internal rate of return (IRR) is 30.69 percent. The benefit-cost ratio (B/C Ratio) is 2.44. the payback period is approximately 3.27 years.

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

The study of costs and returns for the eco-industrial area project determined that the project's net present value (NPV) is 16,239,460,167.89 baht. The internal rate of return (IRR) is 41.28 percent. The benefit-cost ratio (B/C Ratio) is 3.06. the payback period is approximately 2.82 years.

4. CONCLUSIONS

This research aims to evaluate the effectiveness of developing an eco-industrial park project. This involves assessing the development costs of industrial land and the eco-industrial areas of Company A, which has over 35 years of experience in developing industrial land. The researchers conducted research within an eco-land development scope covering approximately 11,120.50 rai. The researchers designed a research tool to assess the willingness to pay of factory operators in industrial areas in Ayutthaya province who have been operating their factories since the development of the industrial park from a conventional industrial park to an eco-industrial park format to determine the willingness to pay for the development of eco-industrial areas by the factory operators.

Then, compare the returns from industrial areas and eco-industrial areas with the amount of investment from developers in each format. Developers will be able to see the value of developing eco-industrial areas from the perspective of factory operators. Developers can use this information to make decisions about whether investing in eco-industrial projects is worthwhile. It was found that with good management by the developer, the development of industrial areas in the form of industrial parks can achieve a return on investment within a timeframe considered worthwhile by the developer, which is within 4-5 years. However, if the development is in the form of eco-industrial areas, there will be additional indirect benefits that can be assessed from the willingness of factory operators to pay for the value of investments in environmentally-friendly industrial areas. This results in a faster return on investment and may meet the demand from many factory operators in the current era who have a positive attitude towards maintaining environmental quality, coexisting peacefully with communities, reducing pollution and impacts that could lead to conflicts, and potentially enhancing economic competitiveness.

From the research, it is evident that respondents are largely interested in environmental issues because they understand the pollution caused by factories and the importance of maintaining environmental quality for surrounding communities. Therefore, developers should opt for the development of eco-industrial areas and invest in pollution treatment systems resulting from the project. For instance, investments might include wastewater treatment systems to maintain surface water quality, air pollution control systems for factories emitting airborne pollutants to ensure air quality, and increasing green areas with gardens or wider buffer zones to create a better landscape and serve as a barrier against air and noise pollution for nearby communities. Investments in waste collection and transportation systems, and establishing industrial waste exchange centers to address solid waste and industrial waste issues, are also recommended.

Alternatively, developers may invest further to enhance the area as an eco-industrial zone by considering attributes beyond those summarized in this research, such as installing solar panels on rooftops or in retention ponds to reduce energy consumption and combat global warming.

Acknowledgement

This thesis was accomplished with great kindness and assistance from the Thesis Advisory Committee. First, I would like to thank Assistant Professor Dr. Allan Sriratana Tabucanon, the researcher's principal advisor. I would also like to thank co-advisor Assistant Professor Dr.Ratchaphong Klinsrisuk. The Thesis Advisory Committee played a crucial role in this research, introducing key principles of research practice and providing essential knowledge and understanding of research tools and theories. Their support was instrumental in the successful execution of this research.

Thank you to all the sample groups who sacrificed their valuable time to participate in the research with intention. Interested in research and are willing to be a part of the research. Both project developers and factory operators are in the Ayutthaya province area. This allows the researcher to analyze the research results in this thesis. Thanks to the partial funding of the Technology of Environmental Management (Special Program), Faculty of Environment and Resource Studies, Mahidol University.

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com

References

[1] Udomsak Silpachavanich. (2013). Economic Valuation of Environmental Resources. Bangkok: P.A.Living.
[2] Areeyapat Phetcharat. (2016). Willingness to pay for benefits from biodiversity. and services from ecosystems: a case study of Bang Krachao area Phra Pradaeng District Samut Prakan Province. Royal Forest Department. Bangkok.
[3] David Gibbs. (2005). *Implementing industrial ecology? Planning for eco-industrial parks in the USA.* Geoforum 36 (2005) 452-464.
[4] Ekaphat Laksakham. (2011). *Cost analysis. and benefits of growing kaffir lime seaweed A case study of Tang Khen Bay Phuket Province.* Chulalongkorn University. Bangkok.
[5] Kanokwan Kamoncharupisut. (2011). *Willingness to pay for purchasing additional personal accident insurance of motorcycle riders in Bangkok.* M.A. Thesis (Human Development). Bangkok.
[6] Kittikhun Saengnil. (2018). *Success factors in developing eco-industrial cities: a case study Bang Pu Industrial Estate.* Dusit Thani College Journal, Bangkok.
[7] Lei Shi. (2014). *Eco-Industrial Parks from Strategic Niches to Development Mainstream: The Cases of China.* Sustainability 2014, 6, 6325-6331.
[8] Natthaphat Areeratchakulkarn. (2016). *Development of a model for measuring industrial park performance Ecological in Thailand*. Dhurakij Pundit University, Bangkok.
[9] Raymond P. Cote. (1998). *Designing eco-industrial parks: a synthesis of some experiences.* Journal of Cleaner Production 6 (1998) 181-188.
[10] Somchai Muijin. (2014). *Guidelines for developing eco-industrial cities in municipal areas Map Ta Phut.* National Institute of Development Administration, Bangkok.
[11] Ukrit Pongwanichanan. (2009). *Study of costs and returns of sugarcane factory production. Don Chedi Subdistrict, Phanom Thuan District, Kanchanaburi Province Crop year 2007/2008*. Srinakharinwirot University. Bangkok.
[12] Umawadi Dechthamrong. (2023). *Analysis of costs and returns of the Nadee Model New Native Chicken Community Enterprise Group*. Chaiyaphum Rajabhat University. Chaiyaphum Province.
[13] Wattana Bunyaraktanya. (2012). *Willingness to pay for mushroom conservation: a case study of Kanchanaburi Municipality.* Sukhothai Thammathirat Open Economic Journal, Year 6, Issue 2. Bangkok.
[14] Wipawee Phonprasit.(2017). *A study of the willingness to pay in the decision to purchase vitamin supplements through online channels among the elderly.* Thammasat University. Bangkok.
[15] Zhe Liu. (2016). *Comparative study on the pathways of industrial parks towards sustainable development between China and Canada.* Resources, Conservation and Recycling.

Corresponding Author: Methavee Siangrai
E-mail address: matakan.mim@gmail.com