IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 3, March 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2016) – 5.264
www.ijiset.com

Criteria and Indicators to Evaluate Green Industrial Zone: The Case of Tan Thuan Export Processing Zone, Ho Chi Minh City, Vietnam

[*]Dieu, T. T. M.

[*]Department of Environmental Technology and Management, Van Lang University
Ho Chi Minh City, 70000, Vietnam

Abstract

A model of green industrial zone has been proposed and characterized by 7 specific points. The model mainly focuses on efficient efficient resources utilization (including materials, energy, and water), prevention and minimization of waste generation at sources by technological solutions, enhancing waste reuse and recycling. Besides, the paper also analyzes and proposes a criteria and indicator system to evaluate how far an IZ/EPZ achieve requirements of a green industrial zones. Evaluation is conducted for IZ/EPZ infrastructure's companies and for enterprises operating in the IZ/EPZ. A case study carried out at Tan Thuan EPZ for 113 enterprises operating in the EPZ helps to confirm the possibility to apply the proposed criteria and indicator system in practice.

Key words: *Green industrial zone, environmentally friendly industrial zone, sustainable development, natural resource conservation.*

1. Introduction

So far, Green Industrial Zone or Environmentally Friendly Industrial Zone is a concept described by different nations aiming at development of industry and industrial zones sustainably. In Canada, Hilton industrial park, Albeta has selected *reuse as the major environmental target*, therefore their investors have designed an effective transportation and consumption, encourage enterprises exchanging and recycling from each other (Paul, 2010)[1]. In the case of Knysna, in order to develop green business zones, all program has strong focused to: (1) sustainable transportation; (2) efficient use of energy and prefer to use clean energy; (3) management and conservation of natural resource; (4) sustainable management of solid waste; (5) sustainable production and consumption[2].

So far, HCMC and Vietnam have several researches and projects studying on environmentally friendly industrial zone (IZ), eco-industrial park ([1], [2], [3], [4]), but it seems still difficult to convince IZs/EPZs to apply. One of the important reasons is that IZs/EPZs do not know clearly how should they do and how much they have to invest to be able to reach such model. If they could evaluate their current situation to find out their weaknesses, they could find the way to overcome their weak points to reach green industrial zone model.

Learning experiences from other countries, considering the national environmental protection legislation, and taking into account strategy of green growth of Vietnam, the paper concentrates on analyzing and proposing model of a green industrial zone for Ho Chi Minh City as well as a criteria and indicator system for evaluating and grading how far an existing IZ/EPZ reaches level of the green industrial zone. A case study carried out at Tan Thuan EPZ helps to assess possibility to apply the proposed criteria and indicator system in practice.

2. Materials and methods

2.1 Criteria and indicator system, and green industrial zone model

The study was conducted by carrying out the following steps:

- Propose *Criteria and indicator system to evaluate green industrial zone* based on the criteria and indicator system to evaluate EIP proposed by Tran Thi My Dieu et al. (2012) [5] and Tran Thi My Dieu and Phan Thu Nga (2013) [6];
- Field survey on status of industrial development and environmental protection activities of Tan Thuan EPZ for collecting data based on the improved criteria and indicator system to evaluate green industrial zone.
- Evaluate level of achievement of Tan Thuan EPZ based on requirements of the improve criteria and indicator system.
- Organize a workshop to get comments from expert (the workshop No.1) on (1) results of evaluation for the case of Tan Thuan EPZ, (2) green industrial model proposed for HCMC and (3) the proposed criteria and indicator system.
- Improve green industrial zone model and organize a workshop to get comments from representatives of enterprises that are operating in Tan Thuan EPZ (the workshop No. 2).
- Update information about enterprises that are operating in Tan Thuan EPZ and evaluate achievement of Tan Thuan EPZ towards the model of green industrial zone proposed. Problems need to be solved or improved is also indicated as a results of this study.
- Report and get comments from the scientific committee of Department of Science and Technology of HCMC on the proposed green industrial zone model and the criteria and indicator system.
- Improve the green industrial zone model and the criteria and indicator system based on comments of the scientific committee of Department of Science and Technology of HCMC.
- Evaluate and determine existing problems that Tan Thuan EPZ needed to be improved based on the selected model of green industrial zone and the criteria and

[1] http://rightsite.asia/en/article/green-industrial-zones-becoming-popular-across-china Green Industrial Zones Growing in China
[2] http://www.knysna.gov.za/business-investment/green-business.

indicator system. Propose action plan for developing Tan Thuan EPZ toward green industrial zone model.

Green industrial zone model was developed based on the following principles:

- The green industrial zone has to ensure industrial development go in hand with environmental protection;
- It is important to characterize green industrial zone in accordance with the National Plan on Green Growth in the period of 2014-2020 [7];
- Criteria on complying with environmental protection regulation is obligated;
- Evaluation is applied at two levels: (1) enterprises operating in an industrial zone (IZ)/export processing zone (EPZ), and (2) IZ/EPZ infrastructure company;
- Evaluation must indicate different evels of achievement compared to the selected green industrial zone so that evaluated IZ/EPZ could find its existing problems and has plan for developing towards the green industrial zone in future.

Based on comments of experts, Tan Thuan EPZ's enterprises as well as by learning experiences of green industrial zones developed in the world, a model of green industrial proposed for HCMC and a criteria and indicator system to evaluate level of achievement towards this model have been completed as presented in Section 3 of this article.

Field survey at Tan Thuan Export Processing Zone and Green Industrial Zone evalution

Direct interview in combination with questionnaire was applied to survey status of industrial development and environmental protection activities of Tan Thuan EPZ. Information collected based on the proposed criteria and indicator system. 113 enterprises operated in Tan Thuan EPZ were surveyed. The collected data were analyzed in accordance to the final proposed criteria and indicator system to find out problems to be solved to develop Tan Thuan EPZ towards the selected green industrial zone of HCMC. All of this information is presented in Section 3 of this article.

3. Results and discussions

3.1 Green industrial zone model

Learning experiences from other countries in the world, commnets from experts through a series of workshops, and comments of enterprises located in Tan Thuan EPZ, a model of green industrial zone in Ho Chi Minh City was proposed based on major principles as follows:

- Industrial activities do not caused negative impacts to the environment, *comply with the nation's regulations on environmental protection* to ensure preventation and minimization of environmental deterioration.
- Suit to the Nation Plan on Green Growth, of which development of "sustainable businesses model", focussing to *efficient resources utilization (including materials, energy, and water), prevention and minimization of waste generation at sources by technological solutions, enhancing waste reuse and recycling* are strong focussed.

The green industrial zone model of HCMC is characterized as follows:

1. IZ/EPZ infrastructure companies and enterprises operated in IZs/EPZs comply with current regulations of environmental protection;
2. IZ/EPZ infrastructure companies invest and operate central wastewater treatment plants (WWTPs) to ensure complete collection and treatment of wastewater generated from belonged enterprises to meet the national discharged standard.
3. Enterprises operated in IZs/EPZs must separate solid wastes at sources, storage, collect and treat them in accordance to current regulations on domestic, industrial and hazardous waste management.
4. Reuse treated wastewater from the central WWTPs for watering green areas in IZs/EPZs, street cleaning or other purposes. Amount of treated wastewater to be reused at least equals to the demand of water for watering green areas of the IZ/EPZ (about 10% of total areas of IZ/EPZ). Reuse of treated wastewater for watering green areas of surrounding residential zones is encouraged.
5. Reuse sludge generated from the central WWTPs of IZs/EPZs to produce soil amendments of the green areas in IZs/EPZs as well as for the surrounding residential zones. Amount of generated sludge to be reused at least equals to the demand of soil amendment for green areas in the IZs/EPZs. It is also encourage IZs/EPZs applying other technical solutions for recycling the sludge such as biogas, biochar, construction materials production, etc.
6. Efficient usage of energy for lighting and industrial production process is requested. Application of renewable energy such as solar energy, biomass energy is also recommended.
7. Enterprises operating in an IZ/EPZ have applied technological and/or management solutions for water saving, efficient use of natural resources and energy, waste minimization at sources, and enhancing waste reuse and recycling.

3.2 Criteria and indicator system to evaluate green indistrial zone achievement

Based on the characteristics of the selected green industrial zone model, the criteria and indicator system to evaluate and grade level of achievement will be applied to: (1) IZ/EPZ level by considering environmental protection activities that IZ/EPZ infrastructure company conducted and (2) enterprises operated in the IZ/EPZ. Each of these levels will be evaluated based on two criterions as follows:

- Criterion 1 is a pre-evaluating criteria and indicator system to assess how far the IZ/EPZ complying with *current regulations on environmental protection;*

- Criterion 2 is a criteria and indicator system for evaluation and grading how far IZ/EPZ meets the requirement of the green industrial zone.

For each level, it is required to pass the pre-evaluating criteria and indicator system before further evaluating and grading level of the green industrial zone.

3.2.1 Criteria and indicator system to evaluate green industrial zone achievement at IZ/EPZ infrastructure's company

Pre-evaluating criteria and indicator system

Pre-evaluating criteria and indicator system is applied to select IZ/EPZ that is suitable for further assessing and grading green industrial zone achievement level. If IZ/EPZ does not satisfy the criteria in the pre-evaluating system, it is under consideration and is not qualified for further assessing and grading level of green industrial zone. The requirements of environmental protection activities in the case of IZ/EPZ infrastructure's company are summarized in Table 1.

Table 1 Requirements of environmental protection activities to be complied by IZ/EPZ infrastructure's company

No.	Requirements of environmental protection activities	Referred legal documents
1	The company should has environmental protection section which complies the following conditions: (a) has at least three (03) staff and (b) environmental managers must obtain at least bachelor degree of environmental management; environmental science, environmental engineering or environmental technology; chemistry; biology and must have at least two (02) years working in environmental field.	Circular No. 35/2015/TT-BTNMT, Chapter IV, Article 15, Clause 1 [8]
2	The company has to implement the IZ/EPZ environmental monitoring program. It is required to report the results of environmental monitoring and other environmental protection activities of an IZ/EPZ as well as of enterprises located in the IZ/EPZ to the provincial industrial zone authorities and Department of Natural Resources and Environment before December 31 of the year.	Circular No. 35/2015/TT-BTNMT, Chapter IV, Article 15, Clause 3 and 4 [8]
3	The company is responsible for preparing and implementing a plan on prevention, response to and remediation of environmental incidents.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 12, Clause 2 [8]
4	The wastewater collection system is separated from the rainwater drainage system	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 8, Clause 2a [8]
5	The common sewer system, the central WWTP and the rainwater drainage system of an IZ/EPZ shall be completely constructed before the IZ/EPZ is put into operation.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 8, Clause 4 [8]
6	The central WWPT of an IZ/EPZ must meet the following requirements: (a) being divisible into various modules suitable to the schedule of occupancy and operation of the industrial park but ensuring treatment of the whole generated wastewater volume up to environmental technical regulations; having an input wastewater flow meter and an independent electric meter. Application of environment-friendly and energy-efficient technologies is encouraged and (b) having a system for automatic and constant observation of the output wastewater flow, pH, temperature, COD, TSS and some other typical parameters of wastewater generated by the IZ/EPZ before wastewater is discharged into receiving waters according to the requirement specified in the decision approving the environmental impact assessment report. The automatic observation system must ensure automatic and constant transmission of data to the provincial-level Department of Natural Resources and Environment.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 8, Clause 3 [8]
7	To constantly operate technical infrastructure facilities of environmental protection of the industrial park	Circular No. 35/2015/TT-BTNMT, Chapter IV, Article 15, Clause 2 [8]
8	Sludge of the central WWTP and sewer system of an IZ/EPZ shall be collected, transported and disposed of or recycled in accordance with regulations on sludge management.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 11, Clause 2 [8]
9	Greenery coverage in an IZ/EPZ must account for at least 10 percent of the IZ/EPZ's total area	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 7, Clause 4 [8]

Based on legal regulations needed to be complied presented in Table 1, criteria and indicators of the pre-evaluating system for IZ/EPZ level is proposed in Table 2. Thus, pre-evaluating criteria and indicator system proposed for the case of IZ/EPZ infrastructure's company has the following characteristics:

- 8 criteria with 12 indicators;
- Maximum score of each indicator is 1. Total maximum score of the pre-evaluating criterion for the case of IZ/EPZ infrastructure's company is 12.
- An IZ/EPZ has total score of the pre-evaluating criterion equals to 90% of total maximum score (= 12

x 0.9 = 10.8) will be continued assessing and grading level of green industrial zone.

An IZ/EPZ that has total score of the pre-evaluating criterion less than 10.8 needs to be improved before further evaluating and grading level of green industrial zone.

Criteria and indicator system for evaluating and grading green industrial zone for IZ/EPZ infrastructure's company

For IZ/EPZ infrastructure's company, the characteristics of the selected green industrial zone are as follows:

1. The IZ/EPZ infrastructure's company must comply with regulations on environmental protection as assessed in the pre-evaluating criteria and indicator system;
2. The IZ/EPZ invests and operates the central WWTP, ensures completely collection and treatment of wastewater generated from all enterprises operating in the IZ/EPZ to meet the national technical regulation on industrial wastewater as assessed in the pre-evaluating criteria and indicator system;
3. Reuse treated wastewater from the central WWTP for watering green areas, street cleaning within the IZ/EPZ and in the surrounding residential areas or other purposes. Reuse treated wastewater from the central WWTPs for watering green areas in IZs/EPZs, street cleaning or other purposes. Amount of treated wastewater to be reused at least equals to the demand of water for watering green areas of the IZ/EPZ (about 10% of total areas of IZ/EPZ). Reuse of treated wastewater for watering green areas of surrounding residential zones is encouraged.
4. Reuse sludge generated from the central WWTPs of IZs/EPZs to produce soil amendments of the green areas in IZs/EPZs as well as for the surrounding residential zones. Amount of generated sludge to be reused at least equals to the demand of soil amendment for green areas in the IZs/EPZs. It is also encourage IZs/EPZs applying other technical solutions for recycling the sludge such as biogas, biochar, construction materials production, etc.
5. Efficient use of energy for lighting is requested and application of renewable energy such as solar energy, biomass energy is also recommended.

Therefore, criteria, indicators and methods for grading green industrial zone for IZ/EPZ infrastructure's company level is proposed as presented in Table 3.

Table 2 Criteria and indicator of the pre-evaluating system for IZ/EPZ infrastructure's company

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
Staff who is responsible for implementing environmental protection activities is arranged (TC_1)	$TC_{1.1}$ = The IZ/EPZ infrastructure's company has a division to conduct environmental protection activities and has at least 3 staff who are in charge of these activities.	$TC_{1.1}$ = number of environmental staff/3	1
	$TC_{1.2}$ = Environmental managers must obtain at least bachelor degree of environmental management; environmental science, environmental engineering or environmental technology; chemistry; biology	$TC_{1.2}$ = 1 if the environmental managers have at least bachelor degree of the indicated field. $TC_{1.2}$ = 0.5 if the environmental managers have bachelor degree of other fields. $TC_{1.2}$ = 0.5 if the environmental managers have education level below bachelor degree but in the indicated field. $TC_{1.2}$ = 0.25 if the environmental managers have education level below bachelor degree and in other fields.	1
	$TC_{1.3}$ = Environmental managers must have at least two (02) years working in environmental field.	$TC_{1.3}$ = 1 if the environmental managers have at least 2 years of experiences in the environmental field.	1
Implement the annual environmental monitoring program (TC_2)	TC_2 = The IZ/EPZ infrastructure's company conducts the annual environmental monitoring program and report to authorities (attached report of the nearest year). *If an IZ/EPZ achieved ISO 14001, this indicator will get 1 score without evident requirement.*	TC_2 = 1 if yes TC_2 = 0 if no	1
Preparing and implementing a plan on prevention, response to and remediation of environmental incidents (TC_3)	TC_3 = The IZ/EPZ infrastructure's company has prepared and implemented a plan on prevention, response to and remediation of environmental incidents (including fire fighting, chemical storages, waste treatment systems of the IZ/EPZ) at least one year from the period of evaluation. *If an IZ/EPZ achieved ISO 14001, this indicator will get 1 score without evident requirement.*	TC_3 = 1 if yes TC_3 = 0 if no	1
The wastewater collection	TC_4 = The IZ/EPZ infrastructure's company	TC_4 = 1 if a separated sewer system is	1

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
system is separated from the rainwater drainage system (TC_4)	constructs a separated sewer system to collect wastewater and rainwater separately	applied TC_4 = 0.5 if a common sewer system is applied	
The common sewer system, the central WWTP and the rainwater drainage system of an IZ/EPZ shall be completely constructed before the IZ/EPZ is put into operation (TC_5)	TC_5 = The IZ/EPZ infrastructure's company constructs the rainwater drainage system, the common sewer system and the central WWTP before the IZ/EPZ is put into operation.	TC_5 = 1 if the system is completed before the IZ/EPZ is put into operation. TC_5 = 0 if the system is not completed before the IZ/EPZ is put into operation.	1
The central WWTP meets the legal requirements (TC_6)	$TC_{6.1}$ = The central WWTP is divisible into various modules suitable to the schedule of occupancy and operation of the IZ/EpZ but ensuring treatment of the whole generated wastewater volume up to environmental technical regulations; having an input wastewater flow meter and an independent electric meter. Application of environment-friendly and energy-efficient technologies is encouraged	$TC_{6.1}$ = 1 if meets the requirements $TC_{6.1}$ = 0 if does not meet the requirements	1
	$TC_{6.2}$ = The central WWTP has a system for automatic and constant observation of the output wastewater flow, pH, temperature, COD, TSS and some other typical parameters of wastewater generated by the IZ/EPZ before wastewater is discharged into receiving waters according to the requirement specified in the decision approving the environmental impact assessment report	$TC_{6.2}$ = 1 if meets the requirements $TC_{6.2}$ = number of auto-monitoring parameters /5 $TC_{6.2}$ = 0 if the effluent does not meet the standard	1
	$TC_{6.3}$ = The automatic observation system of the WWTP must ensure automatic and constant transmission of data to the provincial-level Department of Natural Resources and Environment.	$TC_{6.3}$ = 1 if meets the requirements $TC_{6.3}$ = 0.5 has the automatic observation system but data is not transmitted to Department of Natural Resources and Environment	1
Proper treatment of sludge from the central WWTP (TC_7)	TC_7 = Sludge of the central WWTP and sewer system of an IZ/EPZ shall be collected, transported and disposed of or recycled in accordance with regulations on sludge management.	TC_7 = 1 if meets the requirements TC_7 = 0 if does not meet the requirements	1
Providing sufficient green area in the IZ/EPZ (TC_8)	TC_8 = Greenery coverage in an IZ/EPZ must account for at least 10 percent of the IZ/EPZ's total area	TC_8 = 1 if green areas ≥ 10% total area of the IZ/EPZ TC_8 = existing ratio of the green area/10% if the existing green area < 10% of total area	1
Total			**12**

Table 3 Criteria and indicator to evaluate and grade level of green industrial zone for an IZ/EPZ infrastructure's company

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
Reuse treated wastewater (TC_9)	The IZ/EPZ infrastructure's company reuses treated wastewater from the central WWTP for watering green area; street cleaning or other purposes inside and outside of the IZ/EPZ (attached the statistic data of amount of reused treated wastewater). Score of this indicator will be determined as follows: TC_9 = Amount of treated wastewater to be reused / Demand on amount of water for watering green area of the IZ/EPZ	TC_9 = 0 if treated wastewater has not been reused yet TC_9 = ratio as presented in the evaluation method x 10	10
Reuse sludge from the central WWTP of the IZ/EPZ (TC_{10})	The IZ/EPZ infrastructure's company has applied different technological solutions to reuse sludge generated from the central WWTP to produce soil amendment or others inside and outside of the IZ/EPZ. Amount of sludge to be reused at least	TC_{10} = 0 if sludge has not been reused yet TC_{10} = ratio as presented in the evaluation method x 10	10

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
	equals to demand of soil amendment for green area of the IZ/EPZ. Amount of sludge to be reused TC_{10} = ---------- Demand on soil amendment for green area of the IZ/EPZ x ratio of sludge in the produced amendment		
Efficient use of electricity for lighting (TC_{11})	The IZ/EPZ infrastructure's company has applied different technological solutions to save electricity for lighting (attached data on amount of electricity consumption before and after applied these solutions)	TC_{11} = 0 if no solution has been applied TC_{11} = 10 if data on electricity saving is available	10
Encourage an IZ/EPZ uses renewable energy (TC_{12})	It is encourage the IZ/EPZ infrastructure's company use renewable energy sources (có số liệu minh chứng về năng lương tái tạo sử dụng được tính điểm cộng) Amount of renewable energy used TC_{12} = ---------- Demand on energy	TC_{12} = + 2 if a plan for trying renewable energy is available TC_{12} = + ratio as presented in the evaluation method x 10	
Total			**30**

Thus, the criteria and indicator system for evaluating and grading level of green industrial zone proposed of IZ/EPZ infrastructure's company is characterized as follows:

- 3 criteria for evaluation and 1 criteria for giving plus score. There are total 4 indicators.
- Maximum score of each indicator is 10. Maximum total score is 30 excluding the plus score.
- An IZ/EPZ infrastructure's company achieves 90% total score of this criteria and indicator system (= 30 x 0.9 = 27) will be recommended to receive certification on "a business of sustainable development".

An IZ/EPZ infrastructure's company that gets lower than 27 score needed overcoming existing problem to move forward to the green industrial zone model.

3.2.2 Criteria and indicator system to evaluate green industrial zone achievement at enterprises's level

Pre-evaluating criteria and indicator system

This pre-evaluating criteria and indicator system is applied to select an IZ/EPZ that enterprises operating in the IZ/EPZ are suitable for further assessing and grading green industrial zone achievement level. If IZ/EPZ does not satisfy the criteria in the pre-evaluating system, it is under consideration and is not qualified for further assessing and grading level of green industrial zone. The requirements of environmental protection activities in the case of enterprises operating in the IZ/EPZ are summarized in Table 4.

Table 4 Requirements of environmental protection activities to be complied by enterprises operating in an IZ/EPZ

No.	Requirements of environmental protection activities	Referred legal documents
1	Enterprises and business establishments that produce a large amount of waste that is likely to seriously affect the environment must specialized units or employees specialized in environmental protection; the environment management systems of which must be certified as prescribed by the government.	Law on environmental protection No. 55/2014/QH13, Chapter 7, Article 68, Clause 3 [9]
2	Implement the environmental monitoring program, make reports in accordance with law, and notify the monitoring results to the owner of the IZ/EPZ infrastructure's company.	Circular No. 35/2015/TT-BTNMT, Chapter IV, Article 16, Clause 3 [8]
3	Applying for registration of hazardous waste source owner or submit periodic reports on hazardous waste management to the provincial Department of Natural Resources and Environment.	Circular No. 36/2015/TT-BTNMT, Chapter III, Article 12 [10]
4	Owners of enterprises, business or vehicles at risk of causing environmental emergencies shall take the following measures: (a) make plans for preventing and responding to environmental emergencies; (b) install equipment and devices serving response to environmental emergencies; (c) provide training for intramural environmental emergency response teams; (d) carry out regular inspections and implement safety measures as	Law on environmental protection No. 55/2014/QH13, Chapter 10, Section III, Article 108, Clause 1 [9]

No.	Requirements of environmental protection activities	Referred legal documents
	prescribed by law; (e) take measures to eliminate the causes of environmental emergencies when finding any sign of environmental emergencies.	
5	Wastewater generated from enterprises: (a) shall be treated to meet the conditions specified in written agreements signed with the owner of the IZ/EPZ infrastructure's company before being connected to the collection system of the IZ/EPZ for further treatment at the central WWTP up to environmental technical regulations before being discharged into receiving waters, except the case provided in Clause 4 of this Article; (b) enterprises, business and service establishments operating in an IZ/EPZ that transfer wastewater to a functional unit for treatment must sign wastewater treatment contracts with the functional unit under current regulations.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 9, Clause 1 [8]
6	Enterprises, business and service establishments operating in an IZ/EPZ that emit exhaust gas and cause noise shall procure and install exhaust gas treatment and noise reduction systems conformable to environmental technical regulations.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 10, Clause 1 [8]
7	Enterprises, business and service establishments operating in an IZ/EPZ that emit exhaust gas on the list specified in the Appendix to Decree No. 38/2015/ND-CP shall register the exhaust gas source owner, observe exhaust gas automatically and constantly and transmit data to the provincial Department of Natural Resources and Environment.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 10, Clause 2 [8]
8	Enterprises, business and service establishments operating in an IZ/EPZ shall separate domestic solid waste, medical waste and hazardous waste; dispose of such waste themselves or sign collection and disposal contracts with qualified units in accordance with law.	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 11, Clause 1 [8]
9	Greenery coverage in enterprises operated in an IZ/EPZ must account for at least 10 percent of the IZ/EPZ's total area	Circular No. 35/2015/TT-BTNMT, Chapter III, Article 7, Clause 4 [8]

Based on legal regulations needed to be complied presented in Table 4, criteria and indicators of the pre-evaluating system for enterprises level is proposed in Table 5. Thus, pre-evaluating criteria and indicator system proposed for the case of enterprises operating in an IZ/EPZ has the following characteristics:

- 10 criteria with 10 indicators;
- Maximum score of each indicator is 1. Total maximum score of the pre-evaluating criterion for the case of enterprises located in an IZ/EPZ is 10.
- An IZ/EPZ has total score of the pre-evaluating criterion of enterprises equals to 80% of total maximum score (= 10 x 0.8 = 8) will be continued assessing and grading level of green industrial zone.

An IZ/EPZ that has total score of the pre-evaluating criterion of enterprises less than 8 needs to be improved before further evaluating and grading level of green industrial zone.

Criteria and indicator system for evaluating and grading green industrial zone for enterprises operating in an IZ/EPZ

Therefore, criteria, indicators and methods for grading green industrial zone for enterprise level is proposed as presented in Table 6 and characterized as follows:

- 6 criteria for evaluation and 1 criteria for giving plus score. There are total 7 indicators;
- Maximum score of each indicator is 10. Maximum total score is 60 excluding the plus score;
- An IZ/EPZ that enterprises achieve 80% total score of this criteria and indicator system (= 60 x 0.8 = 48) will be recommended to receive certification on "Green Industrial Zone";
- Each enterprise operating in the IZ/EPZ achieve score of both pre-evaluating system, and evaluating and grading criteria and indicator system equals to 80% of maximum score will be recommended to receive certification on "business of sustainable development".

IZs/EPZs that enterprises level gets lower than 48 score needed overcoming existing problem to move forward to the green industrial zone model.

IZs/EPZs pass the evaluation for IZ/EPZ infrastructure's company level and enterprise level will be recommended to receive the certification on "Green Industrial Zone".

Table 5 Criteria and indicator of the pre-evaluating system for enterprises operating in an IZ/EPZ

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
Staff who is responsible for implementing environmental protection activities is arranged (TC_1)	Each enterprise operating in the IZ/EPZ that arranges at least 1 staff for implementing environmental protection activities (called environmental manager) will get 1 score of this indicator. Enterprises that do not have environmental managers but they have staff taking care of this task as a part of his or her task will get 0.5 score of this indicator. *If an enterprise achieved ISO 14001, this indicator will get 1 score without evident requirement.* Other situation differs from the above mentioned will get 0 score.	$TC_1 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}}$	1
Implement the annual environmental monitoring program (TC_2)	Each enterprise operating in the IZ/EPZ that conducts the annual environmental monitoring program and report to authorities (attached report of the nearest year of evaluation) will get 1 score of this indicator. Enterprises that have not conducted monitoring program yet will get 0 score of this indicator. *If an enterprise achieved ISO 14001, this indicator will get 1 score without evident requirement.*	$TC_2 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}}$	1
Registration of hazardous waste source owner or submit periodic reports on hazardous waste management (TC_3)	Each enterprise operating in the IZ/EPZ that generates an amount of hazardous waste greater than 600 kg/year registering for hazardous waste source owner will get 1 score of this indicator. Each enterprise operating in the IZ/EPZ that generates an amount of hazardous waste smaller than 600 kg/year has to submit annual hazardous waste management report at least for the nearest year of evaluation will get 1 score of this indicator. Enterprises that have not conducted registration for hazardous waste owner or hazardous waste management report yet will get 0 score of this indicator. *If an enterprise achieved ISO 14001, this indicator will get 1 score without evident requirement.*	$TC_3 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}}$	1
Preparing and implementing a plan on prevention, response to and remediation of environmental incidents (TC_4)	Each enterprise operating in the IZ/EPZ that has prepared and implemented a plan on prevention, response to and remediation of environmental incidents (including fire fighting, chemical storages, waste treatment systems of the enterprise), at least for the nearest year of evaluation will get 1 score of this indicator. Enterprises that have not conducted yet will get 0 score of this indicator. *If an enterprise achieved ISO 14001, this indicator will get 1 score without evident requirement.*	$TC_4 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}}$	1
Collection and treatment of wastewater (TC_5)	Each enterprise operating in the IZ/EPZ has to collect and pre-treat wastewater (if necessary) to meet the conditions specified by the IZ/EPZ infrastructure's company before connecting to the common sewer system of the IZ/EPZ. This is evaluated by the monitoring result or confirm from the IZ/EPZ infrastructure's company. If this is satisfied, the enterprise will get 1 score of this indicator. If an enterprise has to treat its wastewater completely before discharged into the receiving, it also get 1 score. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_5 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}}$	1
Noise and air pollution treatment (TC_6)	Each enterprise operating in the IZ/EPZ that emit exhaust has and cause noise has treated to meet the national environmental technical regulations (this is evaluated by the monitoring result of the nearest year of evaluation) will get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this	$TC_6 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises in the IZ/EPZ that emit exhaust gas and cause noise}}$	1

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
	indicator.		
Collect and treat domestic solid waste (TC_7)	Each enterprise operating in the IZ/EPZ that separate and store domestic solid waste at source properly, dispose of such waste itself or sign collection and disposal contracts with qualified units in accordance with law (evaluating by the contract of the nearest year of evaluation) will get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_7 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}}$	1
Collect and treat industrial solid waste (TC_8)	Each enterprise operating in the IZ/EPZ that manage industrial solid waste at source properly and sign collection and disposal contracts with qualified units in accordance with law (evaluating by the contract of the nearest year of evaluation) will get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_8 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises in the IZ/EPZ that generate industrial solid waste}}$	1
Collect and treat hazardous waste (TC_9)	Each enterprise operating in the IZ/EPZ that manage hazardous waste at source properly and sign collection, dispose of such waste itself or sign collection and disposal contracts with qualified units in accordance with law (evaluating by the contract of the nearest year of evaluation) will get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_9 = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises in the IZ/EPZ that generate hazardous waste}}$	1
Providing sufficient green area in the enterprise (TC_{10})	Each enterprise operating in the IZ/EPZ that arranges at least 10 percent of its total area for greenery coverage will get 1 score of this indicator. In the case of its greenery coverage less than 10% of its total area, its score will be calculated by the ratios of it existing green area/10.	$TC_{10} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}}$	1
Total			**10**

Table 6 Criteria and indicator to evaluate and grade level of green industrial zone for enterprises operating in an IZ/EPZ

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
Implement annual waste auditing (TC_{11})	Each enterprise operating in the IZ/EPZ that conducts annual waste auditing at least for the nearest year of evaluation will get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_{11} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}} \times 10$	10
Minimization of waste gereration at source (TC_{12})	Each enterprise operating in the IZ/EPZ that has applied solutions to minimize waste generation at source (including separation, recovery, reuse and recycling within the enterprise) and has statistic data about amount of waste was reduced will get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_{12} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}} \times 10$	10
Saving domestic water supply (TC_{13})	Each enterprise operating in the IZ/EPZ that has controlled amount of domestic water supply for staff and labor in the enterprise (L/person.day or L/person.ship) less than or equals to the standard will get 1 score of this indicator. The reference data is 120 L/person.day. If it is higher than this value, the score will be estimated as follows: [1 - (amount of water supply - 120)/120]. Enterprises do not have separated data on domestic water supply but the data on total water supply for	$TC_{13} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}} \times 10$	10

Criteria	Evaluation method	Evaluation	
		Scoring	Maximum score
	production activities of the enterprise (estimated by total amount of water supply/total area.day) meets the standard, will also get 1 score of this indicator. Enterprises that reuse rainwater as water supply will also get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.		
Saving water supply for production process (TC_{14})	Each enterprise operating in the IZ/EPZ that has controlled amount of water supply for production processes (in average of 40 m^3/ha.day for 60 percent of total area of the enterprise in accordance with QCVN 07:2010/BXD [11]) less than or equals to the standard will get 1 score of this indicator. If it is higher than this value, the score will be estimated as follows: [1 - (amount of water supply - 40)/40]. Enterprises that reuse rainwater as water supply will also get 1 score of this indicator. Enterprises that reuse treated wastewater of the central WWTP or its WWTP for any purpose will also get 1 score of this indicator.	$TC_{14} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}} \times 10$	10
Efficient use of electricity for lighting (TC_{15})	Each enterprise operating in the IZ/EPZ that has applied solutions to save electricity for lighting (estimated by amount of electricity consumed/lighting area compared to the standard) will get 1 score of this indicator. Enterprises that use renewable energy for lighting are also get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_{15} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}} \times 10$	10
Efficient use of electricity for production processes (TC_{16})	Each enterprise operating in the IZ/EPZ that has applied solutions to save electricity for production processes (with data on amount of electricity reduction after applied the solutions) will get 1 score of this indicator. Enterprises that use renewable energy for lighting are also get 1 score of this indicator. Enterprises that have not complied with this requirement yet will get 0 score of this indicator.	$TC_{16} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}} \times 10$	10
Encourage enterprises to use other energy sources efficiently (TC_{17})	Each enterprise operating in the IZ/EPZ if use other energy sources and has applied solutions to use energy efficiently (with data on amount of energy reduction after applied the solutions) will be added 1 score. Enterprises that reuse excess heat from their production processes or use renewable energy for production processes (including solar energy, wind energy, biomass energy, etc.) will also be added 1 score.	$TC_{17} = \frac{\text{Total score of all enterprises in the IZ/EPZ}}{\text{Total number of enterprises operating in the IZ/EPZ}} \times 10$	10
Total			**60**

3.3 Evaluation and Grading Level of Green Industrial Zone for Tan Thuan EPZ Infrastructure's Company

On the basis of current environmental protection activities observed and data collection from Tan Thuan EPZ, results of evaluation by the pre-evaluating criteria and indicator system for the case of Tan Thuan EPZ infrastructure's company is summarized in Table 7. The pre-evaluating results indicate that Tan Thuan Ltd. Co. is satisfied for further evaluating and grading level of green industrial zone.

Evaluation results of Tan Thuan EPZ infrastructure's company based on the criteria and indicator system for evaluating and grading level of green industrial zone summarized in Table 8 indicated that Tan Thuan Ltd. Co. is qualified to recommended to receive certification on "*Business of Sustainable Development*".

Table 7 Evaluation results of Tan Thuan EPZ infrastructure's company based on the pre-evaluating criteria and indicator system

Criteria	Evaluation method	Evaluation score
Staff who is responsible for implementing environmental protection activities is arranged (TC_1)	$TC_{1.1}$ = The IZ/EPZ infrastructure's company has a division to conduct environmental protection activities and has at least 3 staff who are in charge of these activities.	1
	$TC_{1.2}$ = Environmental managers must obtain at least bachelor degree of environmental management; environmental science, environmental engineering or environmental technology; chemistry; biology	1
	$TC_{1.3}$ = Environmental managers must have at least two (02) years working in environmental field.	1
Implement the annual environmental monitoring program (TC_2)	TC_2 = Tan Thuan Ltd. Co. conducts the annual environmental monitoring program and report in accordance with law	1
Preparing and implementing a plan on prevention, response to and remediation of environmental incidents (TC_3)	TC_3 = Tan Thuan Ltd. Co. has prepared and implemented a plan on prevention, response to and remediation of environmental incidents	1
The wastewater collection system is separated from the rainwater drainage system (TC_4)	TC_4 = Tan Thuan EPZ has been constructed a separated sewer system to collect wastewater and rainwater separately	1
The common sewer system, the central WWTP and the rainwater drainage system of an IZ/EPZ shall be completely constructed before the IZ/EPZ is put into operation (TC_5)	TC_5 = Tan Thuan Ltd. Co constructs the rainwater drainage system, the common sewer system and the central WWTP before the IZ/EPZ is put into operation	1
The central WWTP meets the legal requirements (TC_6)	$TC_{6.1}$ = The central WWTP is operated properly to treat wastewater from the EPZ to meet the national technical regulations on industrial wastewater discharges in accordance with QCVN 40:2011/BTNMT, level B; having an input wastewater flow meter and an independent electric meter.	1
	$TC_{6.2}$ = The central WWTP of Tan Thuan EPZ has a system for automatic and constant observation of the output wastewater flow, pH, temperature, COD, TSS before wastewater is discharged into the receiving	1
	$TC_{6.3}$ = The automatic observation system of the WWTP has automatic and constant transmission of data to Department of Natural Resources and Environment of HCMC.	1
Proper treatment of sludge from the central WWTP (TC_7)	TC_7 = Sludge of the central WWTP has been collected, transported and disposed of in accordance with regulations on sludge management.	1
Providing sufficient green area in the IZ/EPZ (TC_8)	TC_8 = Green area of Tan Thuan EPZ reaches 18.71 ha/172.7 ha filled up area = 10.8%. If estimated based on total grass area with the EPZ, this value is 55 ha/300 ha = 18.3%	1
Total		**12**

Table 8 Evaluation results of Tan Thuan EPZ infrastructure's company based on the criteria and indicator system for evaluating and grading level of green industrial zone

Criteria	Evaluation method	Evaluation Score
Reuse treated wastewater (TC_9)	So far, with total green area of 18.7 ha of total 172.7 ha filled up, Tan Thuan Ltd. Co. has invested a wastewater treatment technology to supply about 100 ± 63 m^3/day of treated wastewater for watering green area within the EPZ (statistic data of 2015).	10
Reuse sludge from the central WWTP of the IZ/EPZ (TC_{10})	Tan Thuan Ltd. Co. has carried out studied and also invested a system to to reuse sludge from the WWTP to produce soil amendment based on the technological process provided by Southern Academy of Agricultural Sciences and Department of Crop Production, Ministry of Agriculture and Rural Development approved to reuse within the EPZ. However, in according to the Circular No. 35/2015/TT-BTNMT, sludge from the central WWTP of Tan Thuan EPZ is considered as hazardous waste, so it is requested to treat as hazardous waste. At present, Tan Thuan Ltd. Co. has to sign contract with a hazardous waste treatment company for further treatment of such sludge. In this case, Tan Thuan Ltd. Co needs more time to prove the possibility to reuse sludge from the WWTP as soil amendment or find out other feasible solution for recycling the sludge. With solutions applied to handle sludge generated from the WWTP, Tan Thuan Ltd. Co. get 5 score of this indicator.	5
Efficient use of electricity	Tan Thuan Ltd. Co. has replaced 626 set of street light within the EPZ (street light	10

Criteria	Evaluation method	Evaluation Score
for lighting (TC_{11})	of 400 W and 250 W) by high presure-sodium light (100 W and 70 W). It helps to reduce about 70% of electricity for lighting (approximately about 700.000 kWh was saved yearly)	
Encourage an IZ/EPZ uses renewable energy (TC_{12})	Tan Thuan Ltd. Co. in collaboration with SolarBK company has prepated a plan for trying a model solar energy with capacity of 100 kwp (approximately of 13.500 kWh/month) in Tan Thuan EPZ in 2017-2018.	2
Total		**27**

3.4 Evaluation and Grading Level of Green Industrial Zone for Enterprises in Tan Thuan EPZ

Pre-evaluation

The resutls of evaluation based on the pre-evaluating system for enterprises operating in Tan Thuan EPZ is described in Fig. 1. It is found from the field study that 79/113 surveyed enterprises have arranged environmental managers and other 10/113 enterprises have staff in charge of environmental protection activities. Therefore, the indicator TC_1 of enterprise level reach only 0.74. 103/113 surveyed enterprises have conducted annual monitoring program in accordance with law as a results of TC_2 gets score of 0.91. Score of TC_3 reach 0.92 as 104/113 surveyd enterprises have registered for hazardous waste owners. 100% of enterprises operating in Tan Thuan EPZ comply with pre-treatment of wastewater and connects to the common sewer system of the EPZ for complete treatment of wastewater before reuse and/or discharged to the recieving and TC_5 get a score of 1.0. All enterprises manage very well domesti domestic solid waste generated and 90/113 surveyed enterprises carry out separation of domestic solid waste at source. All enterprises comply with industrial solid waste (TC_8 = 1) and hazardous waste management (TC_9 = 1). Beside these strong point, several enterprises in the EPZ has not arranged sufficient green area (TC_{10} = 0.56), have not prepared plan on prevention, response to and remediation of environmental incidents (TC_4 = 0.50 or only 56/113 surveyed enterprises have the plans), and exhaust gas from some enterprises have not been treated properly (TC_6 = 0,55).

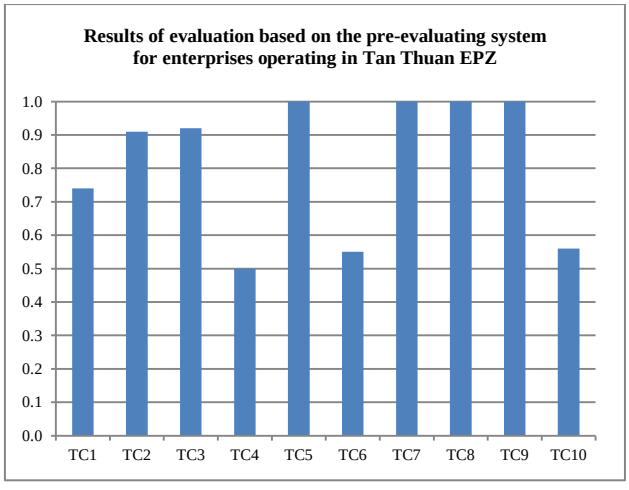

Fig. 1 Resutls of evaluation based on the pre-evaluating system for enterprises operating in Tan Thuan EPZ.

Total score achieved from evaluation by the pre-evaluating criteria and indicator system for enterprise level is 8.18 and qualified for further evaluating and grading level of green industrial zone at the enterprise level.

Evaluating and grading

Resutls of evaluation based on the criteria and indicator system for evaluating and grading level of green industrial zone at enterprise level for 113 enterprises operating in Tan Thuan EPZ is summaried in Table 9.

Table 9 Evaluation results of enterprises operating in Tan Thuan EPZ based on the criteria and indicator system for evaluating and grading level of green industrial zone

Criteria	Evaluation score
Implement annual waste auditing (TC_{11})	0.53
Minimization of waste gereration at source (TC_{12})	3.01
Saving domestic water supply (TC_{13})	7.54
Saving water supply for production process (TC_{14})	5.40
Efficient use of electricity for lighting (TC_{15})	8.14
Efficient use of electricity for production processes (TC_{16})	0.35
Encourage enterprises to use other energy sources efficiently (TC_{17})	0.35
Total	**25.32**

Total score reaches only 25.32 < 48, thefore it is not qualified yet to consider Tan Thuan EPZ as a green industrial zone.

Ingernal, the enterprises need to pay more attention on waste autditing, waste minimization at source, water saving and efficient use of energy for production activities.

4. Conclusions and recommendations

4.1 Conclusions

Results of the study allow concluding that:

- The proposed green industrial zone model seems to be suited to Ho Chi Minh City and Vietnam green growth strategy. It is characterized by 7 specific points indicating clear target for IZ/EPZ to move forwards.
- The proposed pre-evaluating criteria and indicator system is helpful to select suitable IZ/EPZ for further evaluating and grading how far the IZ/PEZ reach requirements of an green industrial zone.
- The proposed criteria and indicator system for evaluating and grading how far the IZ/EPZ reach requirements of an green industrial zone is applicable and is able to quantitatively evaluation for the IZ/EPZ

infrastructure's company level and enterprise level. It helps to identify strengths and weaknesses of each level. The case study at Tan Thuan EPZ confirms the feasibility of practical application of these proposed criteria and indicator system.

4.2 Recommendations

It is expected the authorities have policy and financial support for pushing the model of green industrial zone into practice as soon as possible.

References

[1] Dieu, T. T. M. (2003). Greening food processing industry in Vietnam: putting Industrial Ecology to work. PhD Thesis, Environmental Policy and Environmental Technology Department, Wageningen University, The Netherlands.

[2] Khoa, L. V. and Dieu, T. T. M. (2003). Ecological transformation of the tapioca processing industry in Vietnam. *Greening Industrialization in Asian Transitional Economies: China and Vietnam*, Edited by Arthur P. J. Mol and Joost C. L. van Buuren, Lexington Books Publisher, pp. 199-224.

[3] Dieu, T. T. M., Mol, A. P. J., Rulkens, W. H. (2004). Environmental reform of food processing industry: an Industrial Ecology approach on Bien Hoa 1 Industrial Zone, Vietnam. International Journal of Business and Society, Vol. 5, No. 1, pp. 29-57.

[4] Tran Thi My Dieu (2006), Greening food processing industries in Vietnam: opportunities and constraints. Environmental, Development and Sustainability (2006): 8: 229-249, Springer 2006.

[5] Tran Thi My Dieu, Phan Thu Nga, Hoang Quoc Hung (2012). Criteria and indicator system to evaluate possibilities to develop towards Eco-industrial Park. International Journal of Environmental Protection, Dec. 2012, Vol 2, Iss. 12, pp.28-41.

[6] Tran Thi My Dieu and Phan Thu Nga (2013). Policy framework to promote establishment and development of Eco-Industrial Park in Ho Chi Minh City and surroungding provinces. Research funded by Deparment of Science and Technology of Ho Chi Minh City.

[7] The Prime Minister's Decision No. 403/QĐ-TTg dated March 20, 2014 on the National plan of green growth in the period of 2014-2020.

[8] Ministry of Natural Resources and Environment (2015). Circular No. 35/2015/TT-BTNMT dated June 30, 2015 on providing for the environmental protection of economic zones, industrial parks, export processing zones and hi-tech parks.

[9] The National Assembly (2014). Law on environmental protection No. 55/2014/QH13 dated June 23, 2014.

[10] Ministry of Natural Resources and Environment (2015). Circular No. 36/2015/TT-BTNMT dated June 30, 2015 on management of hazardous wastes.

[11] QCVN 07:2010/BXD (2010). Vietnam building code on urban engineering infrastructure.