

Sustainable industrial estate by managing the building coverage ratio in Cibitung Industrial Town, Indonesia

T M T Budiyanto¹, I S Prajitno^{1,2} and H S Hasibuan¹

¹ School of Environment Science, Post Graduate Universitas Indonesia, Indonesia

² Industrial Engineering Department, Universitas Indonesia, Indonesia

E-mail: tmariatb18@gmail.com

Abstract.

The problem faced in the management of the industrial estate is the development of industrial buildings which are not in accordance with the existing environmental regulations, especially the building coverage ratio (BCR). This violation is due to the limitation of industrial land owned, and the tenant's desire to maximize building area. This research conducted at Cibitung Industrial Town, Indonesia, to assess the compliance of industrial building in complying with environmental regulations, and efforts by industrial estate manager together with industrial communities to meet building regulations. The compliance is shown from the conformity of the tenant's BCR to the building provisions contained in the regulation within the industrial estate; which is maximum 60% from land owned. And whether the rest of green open space (GOS) area can still be maintained at a minimum 10%. This study found tenant's building density (BCR) at 24.55% population was 84.77%, and the rest of green open space at 21.56% population was only 2.49%. Excessive building development and expansion by the industrial communities, led to a continued reduction in green open space as a rainwater absorption area. It is resulting the rainfall runoff directly into the environmental drainage system, and causing flooding in the region.

Keywords: sustainable eco-industrial park, industrial estate management, building coverage ratio, groundwater conservation, open green space

1. Introduction

According to Phoochinda W (2013), managing of a successful sustainable industrial areas is a joint effort between industrial estate management, industrial communities (tenants/factory owners/warehouses), and also local government institutions, to comply with environmental regulations. Among them is to comply with the building regulations, which is the conformity between the new building and expansion with the provision of building, that is applied to the industrial estate. The problem faced in the management of the industrial estate is the building development which is not in accordance with the existing environmental regulations, especially the building coverage ratio (BCR). This is due to the limitation of industrial land availability, and the tenant's desire to maximize their land. Excessive development and expansion by the industrial communities led to a continued reduction in green open space as a rainwater absorption area. It is resulting from the rainfall runoff directly into the environmental drainage system and causing flooding in the region.



This study conducted at Cibitung Industrial Town, Bekasi – Indonesia, to assess the compliance of industrial tenant's building in complying with environmental regulations, and some efforts are done by estate manager together with industrial tenants to meet building regulations in industrial estates. The compliance of the industrial community is shown from the conformity of the tenant's building coverage ratio (BCR) to the building provisions contained in the regulation within the industrial estate; which is maximum 60% from the land owned by industrial tenants. And whether the rest of green open space areas are still can be maintained at a minimum of 10% from the land owned by tenants. Managing of the successful sustainable industrial estate is a joint responsibility of a lifetime relationship, between estate manager and the industrial communities. It is important to continually maintain the level of building densities while maintaining the availability of green open spaces as rainwater absorption and air circulation within the industrial environment.

According to the management of the industrial estate, there are indications of violations of BCR and the reduced area of green open spaces, in some tenants within the industrial area of Cibitung. The building development mismatches with Building Permit can occur from the beginning of the construction of the factory/warehouse, as well as at the stage of development/expansion of tenant buildings. At Figure 1 we can see an automobile tenant parking lot on 20 hectares at Flores Road has built almost all of its land area with pavement to optimize the vehicle stock parking facility, leaving only 1.5% of the land area of green space, is estimated to have caused flooding because of the high rainfall runoff.



Figure 1. Automotive manufacturer's stock yard parking lot on Flores Road.

Source: DigitalGlobe, Google Maps 2016

2. Methodology

The research designed using survey method and conducted from 15 June 2016 until 21 September 2016. The survey is using questioner sent to 167 companies, all the industrial tenant in the Cibitung Industrial Town, Bekasi-Indonesia. Data collected from 52 respondents who voluntaries filled the questionnaires, and information from the interview with plant manager, the estate manager, government institution officer, and study the literate. Questioner designed to gather the information from tenants such as: tenant's data for the area of land, building, utilities and green open space; tenant's perceptions to estate management role in supervise the tenant's building construction process; and tenant's efforts for water conservation already run, and tenant's tendency in developing their building. Interviews and another information gathering obtained from several parties: industrial estate

manager for environmental regulations of the area, officials of the Bekasi Regency Building Service for the regulation to build and supervise the Regional Government, and officials of the Association of Industrial Zones for information compared with the other industrial area. Tenant's building and open green space area calculated based on the digitized site maps using Google Maps and site plan drawing from estate management.

The population at total Cibitung Industrial Town are 450 tenants, and the population for this research is the total companies in the phase 2 development area with total 167 tenants. The number of samples is the number of all tenant who filled the questionnaire, 52 respondents.

This study was conducted to assess the compliance of industrial communities in complying with environmental responsibility regulations, and the efforts by industrial estate manager together with tenants to meet building regulations in industrial estates. The compliance of the industrial community is seen from the conformity of the tenant's building (factory/warehouse) to the building provisions, contained in the building regulation applied within the industrial estate. The study for the effort to comply with building regulations is a review of all efforts have been done and will be done by tenants in overcoming the mismatch of factory building/warehouse to building regulation. This can be indicated which efforts are possible and can be applied in the policy of industrial estate management, to encourage industrial communities to support environmental regulations.

This research was conducted with the aim to:

- Analyze the conformity of building construction or building expansion by all tenant to the regulation of building regulation in the industrial estate, by comparing all tenant's area in their land, building, utilities and green open spaces, with the standard building coverage ratio (BCR) is maximum 60%, and the rest of green open space is minimum 10%, from the land area owned by a tenant.
- Evaluate the tenant's perception from questionnaires using a Likert scale, and interview how industrial estate management already runs their role in the process of tenant's building construction. The effect of building regulations with tenant's building construction and expansion supervised by estate manager, and the law enforcement of implementation the regional and industrial estate regulations.
- Analyze the industrial communities efforts in complying with environmental regulations, which still affordable with the tenant to compensate their excessive building coverage ratio. This study to collect the tendencies of tenants in water conservation and managing their green open space to give an alternative for the industrial estate management policy, for implementing the environmental management of the sustainable industrial town.

3. Sustainable Eco-Industrial Park (EIP)

The Eco-Industrial Park (EIP) concept, or managing the sustainable environmentally friendly industrial zones, was introduced by the US President's Council on Sustainable Development in 1996, published by Lowe (2001). In general, the concept of EIP is the management of industrial zones by involving industrial communities within industrial areas to participate in minimizing waste expenditure, material, land, water and energy utilization efficiency, enhancing environmental and visual quality of the area, increasing business profits, as well as increasing the socio-economic benefits for the communities surrounding the industrial area.

Green open space within an industrial estate, is an open area managed as a rainwater absorption, it can be the green belt of forest and reforestation area, and an area for retention ponds to accommodate rainwater runoff. The green open space is also present within the factory lands owned by industrial communities, which function in addition to being the soil surface for rainwater infiltration, the supply of oxygen, and as well as a garden planted with protective trees and natural flower plants.

This research based on some previous research at the importance of green open space functions, that related with the managing of green open space to still available in the lots owned by tenants. Some thoughts we can see as follows:

- Air temperatures in urban areas are heating up (Alikodra, 2014), primarily due to the reduced role of plants as microclimate regulators and pollutant absorbers, in tune with the widespread and spreading of green space. Ideally, in the urban is allocated 30% of land for green open space. Vegetation is capable of absorbing pollutants, increasing the soil's capacity to absorb rain water, and lowering the hot temperatures.
- According to Effendi (2013), the area where the entry of surface water or rainwater into the soil to fill the ground water which is called recharge area, green open space overgrown vegetation acts as a very good recharge area because it can withstand the rate of rainwater runoff, so rain water has longer time to undergo infiltration into the soil. If the rate of groundwater retrieval in the aquifer exceeds the rate of filling, there will be a decrease in groundwater volume and an increase in the volume of water equal to the volume of water removed from the aquifer; this condition allows the occurrence of land subsidence. Thus the green open space functions in addition to withstanding the rate of rainwater runoff, as well as to balance the volume of water below the soil surface and reducing the possibility of land subsidence.
- Urban development physically tends to consume green open spaces and make it become a wake area (Rahmy, 2012). The proportion of land covered by building and pavement is increasing and ecologically causing various disruptions to natural processes in urban environments. Among the disturbances are increased air temperature, flood frequency and air pollution and reduced biodiversity; from the social aspect of citizens increasingly the lack of green open spaces as a place of activity and social interaction. Based on the calculation of the need for green open space as a provider of oxygen per-person is an area of 8.3 m²; if each industrial tenant leaves 10% of their land area for green space, then every 1 ha of land will have 1.000 m² of green open space that can provide the oxygen for about 120 people.
- According to Rizal (2016), one of 18 indicators for managing successful industrial estate performance suggested by the Organization for Economic Cooperation and Development (OECD), is the proportion of natural land use. The area of green open land (natural) is very important to ensure the level of building density compared with the land area owned, still within the limits of applicable rules. By planting natural vegetation within the plant environment and also around the industrial estate environment, it can absorb the residues released by manufacturing activities (pollutants), and also an addition to beautifying the environment. Vegetation that can be planted in the manufacturing environment can be natural forest plants, grasses, flowers, or ponds with a fountain.

Some theories can be taken from those researches as: the green open space as a rainwater infiltration to groundwater balance and reduce the possibility of land subsidence; open space with vegetation produce the oxygen and reduce the pollutant in the air; and the green open space as a place for staff activity, social interaction and beautifying the environment.

From some literature mentioned the environmental management of sustainable industrial estate can be realized by considering 3 important aspects as follows:

- Implementation of consistent industrial estate regulations and oversight of the implementation of the regulation itself. The basis of regional regulations is the regulations of the Ministry of Industry, the regulation of the local government, and the environmental regulations governing the industrial estate and its management. The environmental regulations of industrial estate are well-disseminated to the industrial community and are regularly refreshed to obtain a common understanding of compliance with environmental management agreements and industrial

community commitments to fulfill them. Industrial Estate Management has also implemented Estate Management Agreement (EMA) signed between the estate managers and the industrial tenants, whose contents the lifetime agreement to comply with the environmental regulations of the industrial estate; such as the provision of the threshold limit value of liquid waste, and the building regulations imposed in the industrial area.

- The implementation of Eco-Industrial Park concept by the of industrial estate management, starting from the determination of the master plan of the area that has considered the ideal composition of industrial lots, facilities and infrastructure and green open space area, that is able to absorb rainwater runoff and maintained as the green belt area, as an environmental climate balancer. The availability and stability of green open space in the area will be an important part to avoid the occurrence of floods due to rainfall runoff with a very high intensity and momentary. The development and expansion of factory/warehouse buildings by tenants potentially exceeds the existing regulatory requirements of the building coverage ratio 60%, and this means reducing the green open space in the industry lots less than 10%. It increase the amount of rainfall runoff directly into the drainage system, and increase the burden of retention ponds and the river watershed, can result flooding in the industrial area. Estate management also undertake periodic maintenance, to ensure that all rainwater drainage systems are either covered or exposed in well maintained, clean from waste and functioning perfectly.
- Implementation of green commitment which is a joint movement between industrial communities, industrial estate management and local communities around the industrial area, to ensure the management of industrial estate will be sustainable for the long term. Poochinda (2013), the implementation of eco-industrial park can be done through cooperation among the existing communities, with the strong role of community leaders – industrial estate management, to make the green commitment of the entire industrial community will be realized.

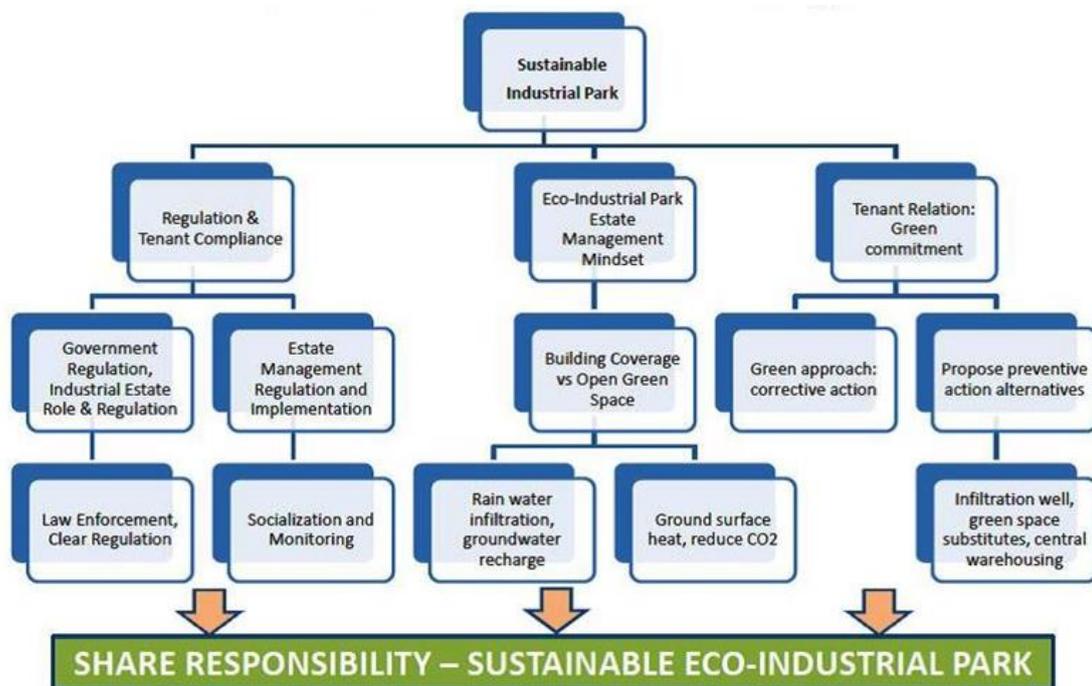


Figure 2. Industrial community green commitment.

The responsibility of environmental management of the industrial estate shall be the joint responsibility between the estate management and the industrial communities, the management of the estate management in creating, supervising and enforcing environmental regulations with the aim that the environment of the industrial estate can be maintained sustainability. The green commitment as a share responsibility from all industrial communities to make sure the implementation of sustainable eco-industrial park, as shown at Figure 2.

4. Conformity of Development to Build Regulations

Lee's research (2012) in the Los Angeles bounty residential, noted the addition/expansion of building area and pavement within 10 years reaches 10.3% and 9.8%, or an increase of 20.1% of the initial land area, and has taken the remaining land area was green open space. If the maximum building coverage ratio (BCR) requirement in industrial area is 60% and the minimum green open space is 10%, while the expansion of building and pavement on tenant land is not well controlled, then in 10 years the remaining green open space area in all tenant land is only about 2%, and will be lost in the next 10 years.

From the study between the age of the building and its density (BCR), there is no relationship between the increased density of buildings together with the age of the building. The building density of the tenant's BCR is not affected by the age of the building but is more affected by tenant compliance with building regulations and the role of tenant construction development supervision, controlled by industrial estate management.

The research undertaken in this section, to find out how the level of conformity of plant/warehouse development to the provisions of regulatory build in the industrial area. The research was conducted by using digitized data maps from each tenant, for their land owned, building, utilities, and green open space area. Calculation of the density level of tenant buildings or building coverage ratio (BCR) in the Cibitung Industrial Estate, can be seen in total population 167 tenants.

At Table 1. Building coverage ratio (BCR) and green open space area calculation, shows the BCR level in the total population of 167 tenants is 29.74%; this is still below the limits of the building regulation in the region of maximum 60%. Similarly, for the total area calculation of green open space total area is 32.21%, this figure is quite safe compared to the applicable green open space regulation which is minimum 10% from the land area owned.

Table 1. Building Coverage Ratio (BCR) and Green Open Space (GOS) calculation at total population, and groups exceeding the building regulation.

Tenant Space Area	Total Population		BCR > 60%		Green Space < 10%		Building Regulation
	Area (m ²)	%	Area (m ²)	%	Area (m ²)	%	
Number of Tenant	167	100,00	41	24,55	36	21,56	
Building with roof	1.436.032	29,74	995.525	84,77	925.162	86,83	Building Coverage Ratio maximum 60% land area
Utilities (parking, roads, drainage)	1.837.336	38,05	140.283	11,95	113.830	10,68	
Green Open Space Area	1.555.580	32,21	38.568	3,28	26.554	2,49	Green Open Space Area minimum 10% land area
Total Land Area	4.828.948	100,00	1.174.376	100,00	1.065.546	100,00	
Building Floor Area (+ 5% multy storey)	1.507.834	31,22	1.095.078	93,25	971.420	91,17	Floor Area Ratio 240% (4 storey)

The conformity level of the total building coverage ratio at 75,45% from the population, get the value of AVERAGE from four classifications (GOOD: if more than 80% tenant conformity with building regulation, AVERAGE: if 60% until 80% tenant conformity, LOW: if 40%-60% tenant conformity

and LESS: if less than 40% tenant conformity). However, there are groups of tenants whose BCR exceeds the maximum limitation 60% of the total 24.55% of the total population, in which the total density reached 84.77%. According to Soeparmoko (2012), mentioned the decline of environmental functions due to, among others, by not giving a decent price (priceless) by its users. The industrial community still has not given priority to the importance of leaving the land of green open space. There are still 21.56% of tenants has green open space area less than the 10% minimum area from total land area allowed, the percentage of total green open space only 2,49%, surpass the existing minimum green open space area requirements, indicating a lack of tenant understanding in appreciating the role of green open space, for air circulation and the function of rainwater absorption into the surface. This can be due to the ineffective role of estate management in disseminating existing regulations, and applying development controls in industrial areas. Or could be the absence of a penalty for violations, resulting in many violations of existing building density limits.

5. Evaluation on the function role of Industrial Estate Management

Research to determine the level of tenant perception, to the role of estate management in the tenant's construction development process. The perception data is tenant assessment obtained from 52 samples. The assessment is done using a scale of values 1 to 5, where 1 is the lowest, and 5 is the highest. The results of the tenant's survey can be seen in Table 2.

Table 2: Questionnaires results on tenant perception: Estate Management Role.

Tenant assesment on the role of estate management in building construction/expansion process	Performance					Total	Mean
	1	2	3	4	5		
1. Supervise tenant building construction:							2,78
a Officers/inspectors regularly come to inspect construction work throughout construction time	2	5	38	7	0	154	2,96
b Tenants often get warning letters for building construction development discrepancies	10	17	24	1	0	120	2,31
c Tenant gets useful feedback from supervisors in the construction development process	0	5	38	9	0	160	3,08
2. Enforcement of building regulations:							2,80
a Estate management explain building regulations, and provide clear guidance as tenants begin construction development	1	7	34	7	3	160	3,08
b Approval of estate management to build very tight obtained by tenant at the time of submission of building permit	6	29	17	0	0	115	2,21
c Estate management provide useful inputs as solutions to construction development problems facing by tenants	2	2	39	6	3	162	3,12

Rating: 1 = strongly disagree; 2 = disagree; 3 = less agree; 4 = agree; 5 = strongly agree

There are 2 important roles of industrial estate management in the process of industrial building factory/ warehouse construction. Tenant perceptions of both roles have average scores as follows:

- The function of tenant development supervision, with a value of 2.78;
- Regulatory enforcement function, with a value of 2.80.

The average rating value of both roles is 2.79. With a scale of 1-5 values used, this rating value is still below the middle value of 3. When the results of this assessment are consulted with the industrial estate management, it's confirmed that the implementation of the supervisory role and enforcement of building regulations is still below the year 2016 target expected industrial estate manager. The expected rating value to be achieved by the industrial estate management is targeted in the rate of 3.

The industrial estate manager role function score 2,78 is under the estate target, has a correlation with the number of tenant violence in their building construction exceeding the maximum 60% limitation (84,77% average) and less green open space minimum 10% (2,49% average). To enhance the estate manager role function in the tenant building construction supervision, and do the socialization of building regulation and to maintain the green open space at tenant land.

6. Efforts to Meet Environmental Regulation by Industrial Communities

6.1. Ground water conservation

The efforts made by tenants in groundwater conservation are not fully addressed as regards the fulfilment of development regulations in existing industrial areas. This is because the supervision has not been running for the application of penalty/sanction of building violations by the estate management or government institution. So that conservation effort are still in the form of voluntary.

Table 3. Efforts on ground water conservation by Industrial Tenants.

Groundwater conservation	Tenant	%	Number	Remarks
1 Rain water storage tank	6	11,54%	6	Water is used for watering plants and cleaning roads/parking lots
2 Rain water absorbtion well	13	25,00%	32	Reduce the rain water runoff directly into the drainage system
3 Biopori holes	9	17,31%	282	Expanding and accelerating rain water into the soil surface
4 Vertical/roof garden	5	9,62%	92 m ²	Cause by space limitation
5 Plants in pot	22	42,31%	484	Cause by space limitation
6 The use paving block			area (m ²)	Accelerating rain water into the soil surface
a. Roads	9	17,31%	102.856	
b. Parking lots	10	19,23%	8.753	
			111.609	18,83% from total utilities area

The purpose of analyzing the tenant's efforts in complying with environmental regulations, which can support successful environmental management of sustainable industrial areas. In research can be seen in environmental management, industrial area has followed 4 main principles in handling environmental problems, such as:

- The principle of economically profitable. Within the tenant compliance industry areas adhering to the rules follow this principle, taking into account between the cost and benefits that are still acceptable to the industrial community. Without a penalty for breach of the provisions, the more and more high price of industrial land compared to the price of building per m²; resulting the industrial tenant prefer to violate the prevailing building provisions. In terms of estate management, the provision of facilities such as logistics center, truck parking area, and joint facilities managed as profit center was not running smoothly, it can be seen from the low industrial tenant interest using this public facility. The management of the

facility should be managed as a facility for industrial tenants with a low cost applied, which is not burdensome and encourages tenants to comply with existing regulations.

- The principle of socially acceptable. Compliance with environmental regulations should be a shared need between industrial estate management and the industrial communities, resulting in a shared sense of responsibility for maintaining the sustainability of a good industrial environment. This can be seen, although not regulated as mandatory, industrial societies have voluntarily implemented environmental conservation programs, especially ground water conservation within their lands.
- Environmentally sustainable principles, the need for certainty on the existence of a sustainable environment. Industrial estate management together with local governments should continue to pursue the implementation of environmental regulations to ensure the sustainability of environmental management of sustainable industrial areas, especially in building construction and expansion by complying with building regulations within the industrial estate area.
- Principle technologically manageable, use of technology that can be managed with properly. In the case of industrial community compliance with the enforcement of environmental regulations, estate manager needs to have policy instruments that can monitor and control the construction of tenant factories/warehouses. In addition to the tenant's concern in carrying out environmental conservation efforts, it can not be separated from the company's strategy in investing the appropriate technology for its production. Business strategies that can promote its industrial products, which are environmentally friendly and also meet the requirements of its consumers, especially in the consumer society from the countries that have applied the green product.

Implemented the sustainable industrial park within the land of some companies, already running well, as we can see in Figure 3, a beautiful garden with pond planted at an automotive factory, and vertical garden implemented in a tight parking area at the food and beverage factory.



Figure 3: Beautiful garden with waterpark, and a vertical garden in the tenant's area.

Some companies in the industrial estate, already implement the 3R program (Reduce-Reuse-Recycle) in managing their industrial waste. One of the tenants applied the 3R program is a national food and beverage company, do the recycle of food product packaging waste collected from their consumers, and use it as the building material for parking lot building, as the corrugated roof.



Figure 4. The roof of the parking lot building from waste food packaging.

6.2. Building control measures

Efforts to control tenant’s development is how the industrial communities plan in controlling the level of building density owned. The study was conducted to determine the tenant tendency when the company will develop their factory/warehouse within their own land. Of the 52 respondents, there are 39 tenants who provide answers to their development plans, and there are 4 tenants who fill the answer with option more than 1 option, so there are 46 total options.

Table 4. Options chosen for tenants building expansion needs.

No	The most likely option for a company, when it comes to development:	Tenant	Pct
1	Renovation of existing buildings with vertical build, or addition of floor level up	9	19,57%
2	Moving some functions to another location that is still in the same industrial area	22	47,83%
3	Estate management provides parking lot facility, logistic center that can be rented by tenant	4	8,70%
4	Estate management provide land replacement for green open space for the advantages of tenant's building	6	13,04%
5	Others: build expansion by utilizing the remaining vacant land owned	5	10,87%
Note: Number of respondent = 39 tenant, Chose > 1 opsi = 4 tenant.		46	100,00%

From the sequence of options above, it can be seen that tenant tendency (47,83%) chooses to do development in the new area, near location (still inside same industrial area). This is assumed because, expansion development will disrupt the existing plant operations so that development options that do not interfere with the operation of the industry are preferred.

The 2nd choice is to build vertically more than 1 level, as many as 19,57% choose this option. If we see the building regulations where the Ratio of Building Floor or maximum floor area can be built, is 240% of the land area, or tenant can build 4 floors/levels with @ 60% BCR from the land owned, then it’s found this option has not been utilized by the industrial community. From the discussion with some respondents, they usually use the industrial processes on the same floor, and rarely done on

different floors (vertical). They already placed the office's area on the upper floors, and also for logistics (raw materials and non-heavy production) warehouse.

From this study, the number of tenant already run water conservation program is only 20,3% (see Tabel.3) even there are some tenants already run good environmental program as their company business strategy or policy. As we know the successful of industrial estate management is a joint effort between estate manager and industrial communities, the estate manager must run a strong drive leadership to initiate the environmental and water conservation program that can be run and agreed together.

7. Conclusions

The violence of building construction/expansion by 24,55% tenant to the building regulation applied in the industrial estate, measured by building density level BCR reaches 84,77%, reduce the less green open space only 2,49%. This makes a treat to green open space availability in the tenant land, more air pollution and less oxygen, may cause land subsidence and less space for social activity and beautiful environments.

The role of industrial estate manager in the enforcement of regulation: (1). There is no written regulation to regulate the minimum green open space area proportion on tenant lands. (2). The role of estate management in oversight of tenant building development has not gone well with the assessment of tenant perceptions and high levels of existing BCR - there is still room for improvement. (3). Facilities of rainwater retaining ponds are still lacking, it takes a land area of 3.5 ha to create artificial ponds.

The role of industrial communities in environmental management: the responsibility for environmental stewardship, run by only a small proportion (about 20%) of existing and well-functioning industrial societies. In this group, the tenant has understood the obligation to carry out efforts in environmental conservation, especially within their factory/warehouse that is in accordance with the environmental conditions of the industry.

Future research:

For industrial estate management: estate manager has more opportunity in applying the Eco-Industrial Park concepts. With a strong drive of estate management's leadership together with the industrial community to create alternative actions to conserve the environment, which enables the industry to be carried out, in an effort to encourage tenants to participate in environmental conservation, especially ground water conservation. The estate management program to implement green commitment must be complemented with an action plan and the time frame that are mutually agreed, so as to realize sustainable Eco-Industrial Park.

For further development of this research: (1) In the formulation of minimum restrictions on green open space area; can be compensated for excessive breach of building coverage ratio (BCR), by making the formulation of measures of groundwater conservation facilities as compensation to be made by the tenant. (2) The optimization of building floor ratio up to 240% of land owned area or vertical build, it has not been utilized by industrial communities. With the more higher price of industrial land, should be the construction of the building/factory already go with vertical (regulation up to 4 floors).

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