Towards Eco-Industrial Park in Malaysia: Promising Opportunities, Challenges and Regulator Roles

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Abstract--- *The progressive development of Eco-Industrial Park (EIP) in most Asian Developing Countries (ADC) has led Malaysia to show interest in EIPs development. The recent transition from the linear industrial park towards EIP is gaining attention in Malaysia due to the mutual benefits that can be achieved via material and utility sharing. The implementation of industrial symbiosis concept in EIP, however, depends on various attributes including law and regulation, finance, research and development, technology, environmental and so forth. Recently, new eco/green concepts industrial parks are upcoming in this country, however, it needs to meet with specified EIP characteristics. A systematic framework of EIP for Malaysia is required and yet to be developed. Prior to such a systematic approach, this paper reviews the current industrial park in Malaysia and presents the way forward transition into EIP. Promising opportunities and challenges of EIP in Malaysia have been thoroughly investigated and highlighted in this paper. Through the preliminary studies, the role of regulators mainly government and government institutions are prominent as a spur to adopt industrial ecology in the EIP development.*

Keywords--- *Eco-Industrial Park, Asian Developing Countries, Industrial Symbiosis, Systematic Framework, Regulator.*

I. INTRODUCTION

Development of EIP is a concept for a new industrial model which gives mutual benefits to the community, economy and environment that simultaneously meet the sustainable development goals (Fleig, 2000). According to

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(Beers, Meylan, Flamminia, & Burrell, 2018), EIP has been described as a group of production or service units co-located together, among local companies not located in the same park or sometimes virtually sited (Brown, Gross, & Wiggs, 1998; Lowe, 1997). EIP seeks to attain improvement of environmental, economic or social benefits by collaborating through mutual symbiosis. The cooperation among industries makes it possible to attain collective benefits much more than when companies work alone (Lowe, 2001). Industrial Park developers are urged to design systemic change in order to ensure the improvement of industrial parks sustainably met. Furthermore, the park developers are strongly encouraged to develop the next generation of industrial clusters that are well-equipped with modern facilities and infrastructure in order to accommodate the next wave of industries along with the Industry 4.0 (Focus Malaysia, 2018).

The progressive development of EIP in most ADC has prompted Malaysia to embark on EIP development. The outcome of this paper is to review the prospect of the existing industrial park in Malaysia and foresee the transformation into EIP in the future. The potential of EIP development in this country is anticipated by benchmarking with global EIP in term of technology and regulatory challenges. It followed by the set of recommendations on regulatory roles towards the EIP development in Malaysia.

II. THE CURRENT LANDSCAPE OF EIP-GLOBAL SCENARIO

Table 1: List of Some EIP Initiatives Globally (Bunjongsiri et al., 2015)

Country	Location of Some EIP Initiatives
Australia	Shenton Sustainability Park, Synergy Park Brisbane, Coolum Eco-Industrial Park
Canada	Burnside Industrial Park, Sarnia Ontario, Bruce Energy Centre Ontario, Portland Industrial District Toronto
China	13 projects (e.g. Dalian, Yantai, Soo Chow, Tianjin, Guiging, Yixing, Taihu, Shanghai, Chong Yuan, Guiyang and Jiangsu)
Germany	The Bayer Chemical Park at Leverkusen, The Chemical Park Krefeld-Uerdingen, Value park, Schkopau
Indonesia	Lingkungan (LIK), Tangerang; Semarang; IndustriSona Maris
India	Naroda; Tirupur Textile sector; Tamil Nadu tanneries; Calcutta foundries; Tamil Nadu paper/sugar; Bangalore water project; Ankleshwar, Nandeseri, Thane–Belapur
Japan	26 projects (e.g. Kitakyushu, Itabashi, Fujisawa, Toyota city)
Korea	Daedok Technovalley (DTV) Development Project, 6 Industrial Parks in Ulsan city
Malaysia	BioXcell Ecosystem Industrial Park in Nusa Jaya
Philippines	Laguna International Industrial Park, Light Industry and Science Park, Carmelray Industrial Park, LIMA, Laguna Technopark, Philippine National Oil Company Petrochem Industrial Park, Clean City Center project (USAID)
Singapore	Jurong Island Industrial Park
Sri Lanka	ADB supported major policy studies in 2002
Taiwan	Tainan Technology and Industrial Park, Changhua Coastal Industrial Park; CSS II (corporate synergy system II) projects, Hua Lian and Kaohsiung
Thailand	I-EA-T and DIW plans
United Kingdom	9 projects (e.g. Crewe green business park, Dyfi eco-park: Wales, Ecotech: Swaffham, London remade eco-industrial sites)
United States	35 projects have been identified, about 6 are operational with completed projects
Vietnam	Amata (environment management), Hanoi Sai Dong (feasibility study)

The EIP approach has been introduced internationally and in many industrial fields that have embraced the notion of industrial ecology. In the USA, the federal government through the President's Council on

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Sustainable Development has encouraged the development of EIPs (Evans, 1995). The development of EIPs also expands similarly in Europe such as Netherlands (Eilering & Vermeulen, 2004), Denmark (Ehrenfeld, 1995) and Finland (Korhonen & Snäkin, 2005). The most interesting and successful case study of EIP is the development of EIP in Kalundborg, Denmark. The linkage between firms in Kalundborg has labeled it as an "industrial ecosystem" (Garner & Keoleian, 1995). Globally, many EIP initiatives were implemented in many countries in order to advance the concept of sustainable consumption and production (SCP). According to research conducted by (Bunjongsiri, Herat, Phung, Sivadechathep, & Chu, 2015) there are a lot of EIP development initiatives globally in Europe, Asia, Australia and US as tabulated in Table 1.

The development of EIPs in Asia has been mainly focused in Korea and China (Geng & Cote, 2004). China has rapidly developed a number of Eco-industrial parks (EIPs) in recent years. It currently has recorded over 100 industrial parks listed in the China national demonstration EIP program (Guo, Tian, Chertow, & Chen, 2018). Tianjin Economic-Technological Development Area (TEDA) is one of the top three national EIPs in China and has become an important Chinese case study in the development of EIP. There are 81 symbiotic inter-company relationships formed in TEDA for the past 16 years involving automobiles, biotechnology, electronics, utilities, food and beverage as well as resource recovery clusters (Shi, Chertow, & Song, 2010). Guigang is another famous Chinese EIP which has been implementing an internal and external industrial symbiosis strategy operates as one of China's largest sugar refineries. Using almost all by-products from sugar manufacturing, downstream businesses have resulted in fresh profits, reduced environmental emissions and disposal expenses as well as improved sugar quality (Zhang, Yuan, Bi, Zhang, & Liu, 2010).

The progressive development of EIP in China has led other Asian countries such as Singapore and Malaysia to show interest in the EIPs. Jurong Island in Singapore has developed three mini EIPs as well as alternative fuel infrastructures to produce long-range planning (Yang & Lay, 2004). Jurong Island is a single petrochemical hub which primarily combines' seven islands off the southwestern coast of Singapore. The concept of Jurong Island is to develop the island from the petrochemical industrial park into EIP in order to achieve safe pollution levels and efficient sharing of resources and facilities. Malaysia, on the other hand, planned to implement industrial symbiosis concept in Pasir Gudang, Johor. In the earlier study, the implementation of EIP concept in the area, however, depends on law and regulation, institution, awareness and capacity building, finance, information, collaboration, research and development, technology, market, geography proximity, industry structure and environmental issues (Teh, Ho, Matsuoka, Chau, & Gomi, 2014).

III. TRANSITION OF CURRENT INDUSTRIAL PARK IN MALAYSIA TO EIP

Malaysia has transited towards a greener and more sustainable industrial concept. The foundation of the green economy is a circular economy with emphasis on renewable energy, restoration, and the elimination of waste. This will help to reduce environmental risks and towards sustainable development. The transition from the ordinary industrial park towards EIP is gaining attention in Malaysia due to the mutual benefits that can be achieved via material and utility sharing. Attempts in the green industrial park have been done in Frontier Industrial Park and Setia Eco Park in Johor and Selangor (Esa, Halog, & Rigamonti, 2017). There are a few specialised parks designed

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to satisfy certain industry's needs, for instance, Kulim Hi-Tech Park in Kedah and Technology Park Malaysia (TPM) in Kuala Lumpur, set up for collaboration between Research and Development (R&D) and technology-intensive sectors (Malaysian Innovation Agency, 2011).

Bio-XCell Malaysia is the first dedicated biotechnology park located in Iskandar Puteri, Johor that implementing the concept of industrial synergy concept in EIP, besides comprehensive infrastructure, high-speed internet access, park maintenance and security, the key facilities there is the Central Utilities Facility (CUF). It was built to provide efficient and reliable utilities for bio-manufacturing such as industrial steam from biomass, chilled water and industrial wastewater management (Bio-xcell, 2017). Another project in Johor state is Eco Business Park 1 has the EIP characteristics. The area is still under development and has already drawn commitments from a number of industries and geared towards being environment-friendly with a number of passive green features to achieve low-carbon footprints (Ecoworld, 2017).

The concept of EIP also coincide with the concept of the circular economy (CE) planned in Pengerang Integrated Petroleum Complex (PIPC) in Johor that integrates oil and gas upstream activities, regasification process, LNG terminal with downstream petrochemical industries. Through the earlier CE study, further research and strong stakeholder's involvement is required towards low carbon development in PIPC (Hishammuddin et al., 2018).

Meanwhile, in Pahang state, Green Technology Park (GTP) was developed as an eco-innovative, self-sustaining industrial park which integrates the concept of zero waste and renewable energy. The main goal is to achieve a green economy with sustainable industries providing zero waste solutions. GTP is surrounded by the oil palm plantation mill and auxiliary plants. GTP consolidates all the technologies integrated renewable energy into a whole 'Zero Waste' model which aligned with its aim at converting waste residues into a useful and green product and utilising energy generated from the park's waste itself (Green Technology Park, 2019).

IV. OPPORTUNITIES AND CHALLENGES OF EIP IN MALAYSIA

Challenges of EIPs development are faced at every stage, from siting to operation. Development of EIP in Malaysia can bring challenges to regulatory and technology issues. Environmental regulations generate disincentives for the industry to develop and implement IS as well as exchange potential useful by-products for other applications. For target businesses to participate in an EIP, several regulatory issues are relevant. The challenges of regulatory issues in Malaysia adapting from (Martin et al., 1996) can be related as follows:

- Waste definition: the needs of distinction of hazardous wastes, solid and secondary materials as per First Schedule of the Regulations of the Environmental Quality (Scheduled Wastes) Regulations 2005 to reuse, reclaim and recycle the waste for other purposes (Department of Environment (DOE) Malaysia, 2016).
- Source definition: the source of pollutants can be determined either from a whole industrial plant or at every emission point. The current definition of the source can burden the significant administrative of industrial facilities due to the total discharge of individual plant may exceed the net discharge of the EIP.
- Reduction of waste: the regulation for encouraging EIP members to reduce their waste needs to be more emphasized instead of changing waste from one type to another without substantially decreasing the total.

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Regulatory issues can be tackled through innovative and strategies approaches to encourage EIP development. Recognition of the benefits of EIP development not only offer the reduction of the source but also reuse and recycle of waste. Generic regulatory strategies for encouraging EIP development can be included as modifying existing regulations, promoting facility-wide permit, market-based approaches, manufacturer "take-back" regulations and streamlining existing permitting and reporting processes. In EIP, technology can play a significant role in helping communities, regulators, developers and managers to fix future issues (Susur, Hidalgo, & Chiaroni, 2019). Symbiotic relationships and unique set of companies in EIP, however, makes its sustainability become difficult (Belaud, Adoue, Vialle, Chorro, & Sablayrolles, 2019). One of the challenges in designing a green supply chain as the basis for an EIP includes the promotion of recycling, regeneration or treatment of resource into green products and the marketing strategy to encourage other companies to purchase such products (Li, Pan, Kim, Linn, & Chiang, 2015). Regulations monitoring intellectual property rights (IPR) is one of the barriers towards establishing green supply chains for EIP due to the limitation in information sharing regarding green innovative technologies between industries.

Besides, the difficulty in applying for permits and time-consuming procedure for resource integration between specialised industries and green technology implementation act as an obstacle towards EIP supply chain development (Li et al., 2015). Furthermore, there may be regulatory restrictions in utilising regenerated or recovered wastes as a substitute for current raw materials for other companies. Specific approval, storage and transportation procedures may be required for controlled resource or waste such as petroleum and fly ash. According to (Ariffin & Saad, 2018), Malaysia has no carbon tax or other green tax policy in combating environmental problems in Malaysia. Malaysia system is more on the incentives offered and penalties imposed on the industries and nations.

V. Regulatory Role in EIP Development in Malaysia

In order to encourage the concept of industrial symbiosis among the industries, a strong commitment of various government institutions may require. According to (Islam, Rahman, & Islam, 2016), government and the government institution have a different role either through planned approach or spontaneous approach of industrial symbiosis. Through the preliminary observation, few regulators either government or government institutions in Malaysia were identified. At the highest top level, Ministry of Energy, Science, Technology and Climate Change (MESTEC) is imperative to foresee how the EIP could be related to MESTEC's main focuses. In the other hands, various government institutions/authorities are relevant and consistent with the EIP development in Malaysia. The following are an appropriate recommendation for each regulator in order to advance in the EIP development in the country.

A. Regulator for Energy Resources Sector

Various government authorities and organizations are associated with the energy sectors in Malaysia particularly Energy Commission (EC), Tenaga National Berhad (TNB), Sustainable Energy Development Agency (SEDA) and Greentech Malaysia. Energy Commission is a statutory body established under the Energy Commission Act 2001 to regulate the energy industry, in particular, the electricity and piped gas supply sectors (Energy Commission, 2019). To ensure the successfulness of EIP in Malaysia, EC shall consider recognizing EIP development as one of the industrial energy efficiency initiatives in Malaysia. One way is by participating in any energy project within the EIP as the capital provider or project advisor. Meanwhile, EC also responsible to solve related issues on specific licensing scheme required for electricity and gas supply within EIP. Meanwhile, TNB as the largest electricity utility provider in Malaysia shall endeavor the EIP implementation through relevant energy initiatives (Tenaga Nasional Berhad, 2019). For instance, TNB could introduce special incentives such as special tariff or electricity bill deduction scheme within the EIP tenants. Detail guideline from TNB is needed to guide EIP tenants developing the self-generation of electricity. It shall comprise the procedure for EIP owner and tenants to export electricity to the national grid, term to sell surplus electricity among EIP tenants if the allowable limit for electricity generation at the grid is exceeded and the limitations for EIP owner and tenants to sell electricity to the national grid.

In general, EIP in Malaysia will underpin the National Renewable Energy Policy and Action Plan (2009) through the electricity generation by renewable energy sources. Malaysia's Feed-in Tariff (FiT) system requires Distribution Licensees (DLs) to purchase renewable energy electricity from Feed-in Approval Holders (FIAHs). SEDA shall provide quotas for the EIP tenant’s as FIAHs in order to encourage the participation of EIP tenants within EIP (Sustainable Energy Development Authority (SEDA), 2019). GreenTech Malaysia is an organisation under the purview of the MESTEC also relatable with the EIP development in Malaysia. The role of GreenTech Malaysia prone to the Government’s 2010 Green Technology Financing Scheme (GTFS). It was introduced to increase the development of the green technology industry by offering access to funding from Participating Financial Institutions (PFIs) to the entrepreneurs and venturing businesses (Greentech Malaysia, 2019). Through this platform, Greentech Malaysia could embark on the financial aid for the EIP implementation. The investment tax allowance for the acquisition of green technology equipment and exemption from the income tax for tenants in EIP shall be considered. They also may participate in adopting low carbon green growth in the EIP development as they already succeed in the development of smart sustainable cities (SSC) previously.

B. Regulator for Environment Sector

In line with the objective of EIP to minimize the negative impacts of industrial activities, full participation of environmental protection agency is crucial. The State Environmental Protection Administration (SEPA) has pioneered the first EIP project in Guigang, China in 2000 along with the development of relevant policies to support the application of industrial ecology (Chiu & Yong, 2004). Meanwhile, in Malaysia, the environmental conservation is mainly under the purview of Department of Environmental (DOE) Malaysia. DOE plays a vital role towards the development of EIP in Malaysia by developing policy, act and regulation for EIP industrial waste utilization that will prompt industries to exploit resources and exchange waste, by-products and waste minimization practice (Teh et al., 2014). There might be some kind of help that could possibly be provided by the DOE such as specific procedure regarding the solid waste treatment and disposal for a centralized waste management system in an EIP. Based on the current regulation, there is a need to specify waste that needs a specific license to be reused/sold/exchanged within EIP (Department of Environment (DOE) Malaysia, 2016). DOE is also to provide any incentives to encourage the industry to utilize their waste and allow industries to exchange or sell their waste. Furthermore, DOE is advocated to have strong networks with industries to materialize an EIP attempt in this country.

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C. Regulator for Water Resources Sector

Water is one of the key resources in EIP that can be exchanged and reuse from cooling water and process water (Islam et al., 2016). The idea of exchanging water between industries within EIP in order to minimize the freshwater consumption and wastewater disposal requires an understanding from the local water supply services company. Due to that, the local water supply company must commit in the EIP development through several initiatives like new water tariff introduction for water reuse and recycle among plants or any additional incentives that they could provide to the tenants in order to attract them to join EIP. Basically, in EIP, park owner/manager act as the middle man to manage the selling and buying cooling water and recycled water between industries. Thus, any issue regarding license or permit required by an EIP manager to implement water exchanging within EIP in Malaysia should be clarified by the water supply company. In addition, the tenants within EIP have to adhere to the safety aspect if water exchange is permitted to be conducted between the industrial plants.

D. Regulator for Financial Initiative

The government's implementation of feasible financial instruments will accelerate the distribution of environmental technology into industries. Malaysian Investment Development Authority (MIDA) is the government's agency for manufacturing and service sectors promotion. MIDA assists businesses that are planning to invest in the manufacturing and services industries, as well as promotes the execution of their projects. MIDA's role is the one-stop processing centre for the application of tax incentives. At current, there are no available incentives or financial schemes matches with the concept of EIP. However, MIDA has provided an incentive for the development of Waste Eco Park (WEP) in the country. It seeks to promoting industry waste recycling, recovery and treatment activities and offers a sustainable solution to the issue of waste management. WEP Developer, Manager and Operator are provided with incentives to encourage the investments in facilities and infrastructure for holistic waste management activities. In the context of EIP, MIDA shall see the development of EIP as an effort similar to the establishment of WEP and entitled for the associated incentives (Malaysia Investment Development Authority (MIDA), 2019). Otherwise, MIDA shall consider new tax incentives to encourage the establishment of EIP in the future.

VI. CONCLUSION

This paper reviews the current development of EIP in the global as well as opportunities and challenges of EIP in Malaysia from the point of view of regulatory issues. The concept of EIP seems to be promising in order to stimulate sustainable development and reduce costs to manage waste produced from industrial plants. In order to promote industrial symbiosis among the industries, a strong commitment of various government institutions is required. The Malaysia government is currently encouraging the establishment of EIP by several innovative and strategies approaches such as introducing feasible financial instruments to hasten the diffusion of environmental technology into industries. Development of Bio-XCell Malaysia and Eco Business Park 1 in Johor proved that Malaysia government committed to developing a sustainable environment. The current work only discusses the regulatory role in developing EIP in Malaysia. It is envisioned that this work can be improved by including other institutions on developing EIP such as educational institution, industry players and park manager.

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