SUSTAINABLE INDUSTRIAL DEVELOPMENT IN ASIAN COUNTRIES: LESSONS LEARNED FROM THE INITIAL PROJECTS OF ECO-INDUSTRIAL PARKS IN INDIA, CHINA AND INDONESIA

THESIS

A thesis submitted in partial fulfilment of the requirements for
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DOUBLE MASTER IS DEGREE PROGRAMME

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ENVIRONMENTAL AND INFRASTRUCTURE PLANNING
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ABSTARCT

SUSTAINABLE INDUSTRIAL DEVELOPMENT IN ASIAN COUNTRIES: LESSONS LEARNED FROM THE INITIAL PROJECTS OF ECO-INDUSTRIAL PARKS IN INDIA, CHINA AND INDONESIA

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Increasing pollution of the environment as result of economic activities, particularly from industry which emits hundreds of air, water, and solid pollutants have led to a growing interest in issues such as sustainable development and ecological modernization. In Asian countries most industrial waste was disposed off in landfills, stored or buried in particular sites, burned or discharged into surface waters with little or no treatment. Nevertheless, those approaches altogether are not enough to solve the problems because they only displace the problem from one medium to another. Currently, industries have become more aware of their responsibilities to protect the environment and start to implement voluntary initiatives to reduce the burden on the environment, shifting from reactive approach to more preventive approach. It is good not only for the environment preservation but also for industries and businesses as a good strategy to attract and fulfil customer needs while creating costs saving. One of the voluntary approaches is an Eco-Industrial Park which is seen as a visionary approach since it was successfully marrying previous approaches such as Cleaner Production and Environmental Management Systems which gives equal attention to economic growth, environmental protection, and social equity.

This paper analysed the practice of eco-industrial park concept in the three projects in three Asian countries, India, China and Indonesia. These three projects with their characteristics have chosen different approaches in becoming an eco-industrial park. In India's case, the project used by-product exchange network as its approach while in China the project used comprehensive environmental system to integrate the goals between the companies, communities and government. On the other hand, in Indonesia the project focused more on enhancing production processes in individual plant in order to increase costs saving and improve environmental quality. Even though the three projects are still in an initial phase but it seems India's project offers more benefits in comparison with the two counterparts. The difference in gain benefits is mostly influenced by the way of selecting approaches and programs beside active participation of stakeholders. Nevertheless, the three projects have not resembled an eco-industrial park yet as the theory expected since they gave less attention to community empowerment.

Keywords: sustainable industrial development; eco-industrial park; pollution prevention; industrial ecology; cleaner production.

GUIDELINE FOR USING THESIS

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PREFACE

This master thesis is concerned with the current trend of industrial development particularly in dealing with issues such as sustainable development and "greening" movement. The shifting approach from reactive to more preventive used by industry and business nowadays is interesting to be analysed. It shows how industry now becomes a part of solution for our better life. Therefore, I wrote the thesis as an attempt to give my contribution to a better condition in industrial development particularly for Asian countries. Besides that, the thesis is dedicated to fulfil my double master's degree programme, the MT Programme Development Planning and Infrastructure Management of the Department of Regional and City Planning of Institut Teknologi Bandung and the M.Sc Programme Environmental and Infrastructure Planning of the Faculty Spatial Sciences at the University of Groningen.

In this special occasion I would like to express my deepest gratitude to my supervisors, Prof. Gerald Linden from RuG and Ir. Haryo Winarso, M.Eng, Ph.D. from ITB, for the valuable input, critiques and discussion that help me finish the thesis on time. I would also like to thank to the Netherlands Education Centre (NEC) and Bappenas for giving me the scholarship that made me possible to study in master's degree programme. Furthermore, I would like to express my gratitude to the following people, without whom this thesis would not exist.

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Groningen, August 2006

Juhansyah

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LIST OF ACRONYMS

APELL	: Awareness and Preparedness for Emergencies at the Local Level
BPX	: By-product Exchange
CEE	: Centre for Environment Education
CETP	: Common Effluent Treatment Plant
CII	: Confederation of Indian Industry
CP	: Cleaner Production
DDT	: Dichlorodiphenyl-trichloroethane
DETDZ	: Dalian Economic and Technological Development Zone
DETDZAC	: Dalian Economic and Technological Development Zone Administration Commission
EIA	: Environmental Impact Assessment
EIN	: Eco-Industrial Network
EIP	: Eco-Industrial Park
EMS	: Environmental Management System
EPD	: Environmental Protection Department
GIDC	: Gujarat Industrial Development Cooperation
GIS	: Geographic Information System
GTZ	: Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Technical Cooperation)
HIPLIK	: Himpunan Pengusaha Lingkungan Industri Kecil
HVAC	: Heating Ventilation Air Condition
IP	: Industrial Park
ISO	: International Organization for Standardization
LIK	: Lingkungan Industri Kecil
LPG	: liquefied petroleum gas
MNCs	: Multi National Companies
MOU	: Memorandum of Understanding
NCPC-A	: Naroda Cleaner Production Centre
NEPL	: Naroda Enviro Projects Ltd.
NGOs	: Non-Governmental Organisations
NIA	: Naroda Industries Association
NIE	: Naroda Industrial Estate
PCB	: Planning and Construction Bureau
RMB	: Chinese people's money, Ren (person) Min (Plural suffix for person) Bi (Currency).
SMEs	: Small and Medium Enterprises
TSP	: Total Suspended Particulate
UNEP	: United Nation Environment Program(me)
UNCED	: United Nation Conference on Environment and Development
WTO	: World Trade Organisation

Chapter I
Background

1.1 Introduction

Beside offering wealth and prosperity by doubling production ability and increasing productivity, industrialization has also produced many externalities. One of the externalities haunting most countries in the world is industrial pollution. Industrial pollution such as contaminated water and land causes not only agriculture productivity to decrease but also significant economic losses to increase through adverse impacts on health and productivity of human being. A number of estimates have been made, for different countries, of the value of these losses for instance, according to the United Nation Human Development Report (2000) the number of premature deaths in developing countries caused by atmospheric pollution is as high as 70% and an estimated US$ 4 billion worth of damage by chronic bronchitis is due to pollution. On a global scale, the release of carbon dioxide and other greenhouse gasses is resulting in the myriad problems of climate change.

Increasing pollution of the environment as a result of economic activities, particularly from industry which emits hundreds of air, water, and solid pollutants, and many other sources of damage to communities and ecosystems at scales ranging from the very local to global, and growing pressure on natural resources has led to a growing interest in issues such as sustainable development[1] and ecological modernization[2]. A key challenge for sustainable development is to break the linkages between continued growth and the quantities of pollutants

[1] Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission, 1987).

[2] Ecological modernisation is the course that recognises the structural character of the environmental problematic but none the less assumes that existing political, economic and social institutions can internalise the care for the environment (Hajer 1995).

discharged to the environment, by reducing the pollution intensity of industrial production. They have influenced policies at all spatial scales from the development of local responses and Local Agenda 21 to international responses such as call for the World Trade Organization to take greater account of environment impact.

Industries, in responses to this wave, have done some efforts to reduce the environmental impacts of products and process associated with industrial systems through the programs such as; zero defects quality[3] or pollution prevention[4] that embodied in the ISO 14001 Environmental Management System (EMS)[5] with environmentally friendly production process. Unfortunately, not all industries have such a high technology both in production process and waste management, particularly industries in developing country and the third world. The installation of high technology waste management and monitoring equipment are beyond the technology, knowledge and monetary because most industries in both countries are small-scale enterprises and face difficulties in adopting better methods which are often capital intensive. It has become "ancient history" that most industries in developing countries and the third world have produced too much waste and dumped it in land, air and water and wanted only to pass along disposal of products to the next users. What happens to the wastes after they are removed, for some industries, is often a case of "out of sight, out of mind" (Daniels and Daniels, 2003). In general most industrial waste was disposed off in landfills, stored in surface impoundments such as; lagoons or pits, discharged into surface

[3] Zero defect quality is a practice that aims to reduce defects in production process as a way to directly increase profits.

[4] Any practice which reduces the amount of hazardous substance, pollutant, or contaminant entering the waste stream or otherwise released to the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reduces the hazards to public health and environmental associated with the release of such substances. Seen at www.mass.gov/epp/info/define.htm on July 31st, 2006.

[5] The ISO 14001 is international standard from the International Organization for Standardization "Environmental management systems - Specification with guidance for use." Details the required elements for an environmental management system, following five EMS principles: commitment and policy, planning, implementation, measurement and evaluation, and review and improvement. Seen at www.hrsdc.gc.ca/en/cs/fas/as/sds/appd_sds03.shtml on July 30th, 2006.

waters with little or no treatment, or burned. Tolentino et al. (1990) classified current industrial waste disposal practices in both countries include the following:

- storage and/or burial on-site
- direct discharge of untreated wastes to watercourses
- discharge of untreated wastes to drains or sewers
- collection and illegal discharge to open land, drains or watercourses
- collection and disposal with domestic waste in a solid waste dump site or landfill
- incineration on-site or off-site

Nevertheless, those approaches altogether are not enough to solve the problems because they only displace the problem from one medium to another, e.g. from landfill to de-inking sludge in the case of paper life cycle and paper recycling. In fact, many of the industries in developing countries have become greater contributors to pollution and natural degradation because the facilities for cleanup and final disposal are insufficient. Mismanagement of the waste has resulted in polluted groundwater, streams, lakes, and rivers, as well as damage to wildlife and vegetation.

Beside the technological, knowledge and monetary constraint, Oeltzschner in von Hauff and Wilderer (2000) identified other problems that can become barrier for environmental protection and pollution prevention practices in developing countries as follow:

- Relatively low level of education and hardly any environmental education which could provide awareness towards environmental protection.
- Political structures which do not support environmental protection. In this respect, the following aspects can be mentioned:
  - highly bureaucratic structures,
  - lack of transparency and accountability in decision making,
  - low salary of bureaucrats which provides the ground for corruption,
  - nepotism and/or the selection of inadequate qualified personnel,

- difficult and complicated methods of procurement; and/or,
- strong influence of political ”authorities” in technical decisions.

For developing countries, economic development is placed on the top priority as machine to enhance social prosperity. Indeed, in some particular places the environment and environment conservation were left behind for the sake of development (World Bank 2000). With the fact that most of industrial development now moved to and sited on developing countries, particularly Asian countries, and because of that Asian countries are so called “factory of the world”, plus the constraints or problems have already stated before the pollution treats have become the greatest in those countries. Then it becomes important issues in those countries how to accelerate the need for development and protect environment.

Hence, a new integrated industrial planning and management mechanism has to be introduced. With the introduction of industrial ecology concept by Frosch and Gallopoulos in 1989 (Heeres et al, 2004), industrial development entered a new perspective of production and process system. This new perspective states that industrial complexes should be designed to reduce the conflict between two systems: the industrial subsystem; and the (mother) ecosystem, on which the industrial activities are dependent and imitate the natural ecosystem as closely as possible (Garner and Keoleian 1995). Industrial development should resemble the natural ecosystem because in such a system, energy and resources are used optimally and wastes are absent.

Contrary to the old perspective which sees all waste as a hazard to health and the environment that must be destroyed or prevented, industrial ecology considers waste an economic resource (Sinha 1993) and by reducing and reusing it means greater profit will be taken. Industrial ecology views industrial systems as part of natural systems and attempts to apply lessons about natural systems to the operation of industrial facilities. The eco-industrial park (EIP) model offers a primary means to apply these tenets. EIP represents a promising strategy to promote sustainable industrial development and implement industrial ecology

concepts. It also provides a new model for community and environment development such as Cohen-Rosenthan (2003, pp.14) stated:

> *"Eco-industrial development presents an archway to a better future. For business, eco-industrial development offers new avenues for profitable companies. For communities, eco-industrial options lead to more rooted businesses, good jobs and a cleaner environment. For local and global ecosystems, eco-industrialism promises a lighter load on the environment".*

EIPs are designed such that industrial areas are developed mimicking a natural ecosystem (Garner and Keoleian 1995). Natural ecosystems are self-contained and self-sustained. They produce zero waste through complex interactions of food chains. EIPs adopt a similar integrated approach that provides industries with the potential to minimize wastes. Processes and industries are seen as interacting systems rather than as comprising of isolated components in a system of linear flows[6]. This involves routing waste materials and energy from the sources of those wastes to other facilities that use them as feedstock (this process is so called as materials life cycle). This results in a shift from wasteful open-linear industrial systems to efficient closed-loop industrial systems. It is suggested that a number of economic, environmental and social advantages can be gained by adopting an EIPs approach such as:

- Waste products from one industry providing the inputs for another, reducing input costs.
- Reduced waste streams mean lower waste disposal costs.
- Waste now has an economic value, increasing profits.
- Creation of a larger and more varied economic base.
- Potential for job creation from the formation of 'niche species' firms.
- Reduced emissions mean less need to separate industrial and residential land uses and consequently reduced movement between the two (Dunn and Steinemann, 1998).

With EIPs approach industries in developing country and the third world have an opportunity to manage their waste to become source without much

[6] Ibid

investment in technology of waste management. It helps companies become more competitive by improving their environmental performance and strategic planning. It also helps communities develop and maintain a sound industrial base and infrastructure without sacrificing the quality of their environments. And it helps government agencies design policies and regulations that improve environmental protection while building business competitiveness.

India, China, and Indonesia have been chosen as an object study in this paper since these countries are new industrial countries and the most pollution contributors in Asia Region (World Bank, 2000). Nevertheless, they are now very concerned with the sound of environmentally industrial development by adopting the concept of EIP with different level of maturity. India started doing the EIP earlier than their neighbours. China, on the other hand, has shown strong enthusiasm to develop many integrated industrial parks or estates. Meanwhile, Indonesia is still conducting an initial feasibility study. Those countries faced different problems and used different approaches to solve them but are still under umbrella of EIP principles. Although their culture may vary from one another, the working environment and structure among them is quite similar, so learning from other's success stories, as well as benefit from other's stories was applicable to others.

1.2 Research Objectives and Research Questions

The purposes of this study are to review the development of Eco-Industrial Park (EIP) projects in India, China, and Indonesia and to extract some important lessons from their experiences. As Cohen-Rosenthal (1999) noted that there is no "one size fits all" answer for eco-industrial development and therefore experiences from other projects are the best lesson to enhance our insight. It will also show, by implementing EIP concept, the changing perception of industry from being part of the problem of environmental degradation to the reality of its becoming part of the solution for development and environmental performance.

In order to obtain those objectives, this research will be developed based on some research questions as follow:

- What are the push and pull factors that make industries in India, China, and Indonesia shift their industrial waste management from "reactive" approach such as end-of-pipe cleanup to "integrative" approach such as eco-industrial park (EIP)?
- How do companies in those countries deal with their disadvantages or limitations, as they have been already stated before, and what benefits they look forward to implementing EIP concept?
- How is the development process conducted and which parties should be involved in the cooperation projects?
- What lesson can be learned from their experiences?

1.3 Methodology of Research

This paper analyzes the implementation of industrial ecology concept in the form of EIP projects in India, China, and Indonesia. It provides detail information about the context in which the concept occurs based on available literature and secondary data. All data were gained through relevant reference such as journals, books, articles, working papers, internet, and so forth.

The nature of this research is exploratory and qualitative using score card method by comparing between theoretical review and the practices. Three research strategies were applied to analyse research data: first, comparing important situational feature of selected EIP projects; second, weighing objectives, stakeholder involvement, and potential areas for improvement from the three cases studied against theory; and third, comparing the potential benefit earned by the three cases reviewed. Through the exploration of the process from designing until executing, this paper found some elements that should be met first before the projects were executed, their characteristics and relationships among stakeholders.

This research will approach the subject through four general steps as follows:

- Firstly, studying the available industrial ecology and EIP literatures and generating the essential factors and pre-requirement to successful EIP project to formulate theoretical framework.
- Secondly, the case studies shall be examined to deliver a clear description about how EIP principles are implemented in India, China, and Indonesia. There are three industrial estates which have conducted initial EIP projects which will be examined and compared: (1) Naroda industrial estate, India; (2) Dalian industrial park, China; and (3) Lingkungan industri kecil, Indonesia. The selected EIP projects were chosen simply because they are the oldest and most developed projects and therefore they are worthwhile as examples to other EIP development projects. In order to compare the three cases, the four aspects would be studied: (1) background; (2) the vision and stakeholder involvement; (3) planned EIP development; and (4) benefits and opportunities.
- Thirdly, the practices of EIP development in India, China, and Indonesia would be analysed based on their *objectives*, *stakeholders' participation*, *potential area of improvement and networking*, and *potential benefits*, and some lessons learned shall be drawn.
- Finally, some general concluding remarks about what can be learned from case studies and some recommendation about what should be enhanced or concerned in building EIP project shall be given at the end of the research.

In order to make the study comprehensive and not too broad this paper only focuses on the implementation of process development and how effective EIPs in reducing and managing industrial waste in both countries and not discussing in-depth detail technique or technology of industrial waste management.

1.4 Report Structure of Research

This research is divided into five sections. Following the introduction section, this describes the background, objectives and research questions, and

methodologies used in conducting research. In general, it highlights how the research shall look like and explore the important issues. The next section draws theoretical framework of eco-industrial park (EIP) which content theoretical formulation and some principle guidelines used in this research.

Section three explores the development process of EIP projects in India, China, and Indonesia along with their specific characteristics. Section four presents the finding and assessing the relevancy between EIP principles and their implementation in each project. Then several lesson learned shall be drawn. Finally, section five summarises the main result from analysis of the implementation of the initial EIP projects in India, China, and Indonesia.

Chapter II
Theoretical Framework of Eco-Industrial Park

2.1. The Idea of Sustainable Development

In recent years, sustainable development has become a popular debate in every scene of our life. It was Rachel Carson, in her book "Silent Spring" published in 1962, who made people realize that the environment has limitation to absorb continuous pollutants from humankind's activities and remain healthy (in her cases studied was the negative effect of the use of chemical pesticides such as DDT (dichlorodiphenyl trichloroethane) in agricultural production)[7]. She showed how the use of pesticides to increase agriculture productivity by protecting it from any pests in fact has destroyed other wildlife particularly large bird such as eagles and condors (Daniels and Daniels 2003). The worst evidence she showed in her book was the effect of pesticides uses have spread out even to humans as well through the natural food chain. Her book has taught us that any activities even though they are intended for development will affect the stability of environment and for long-period will also influence human being.

Her work then inspired people to be aware with environmental protection while doing development. One of them was in 1987 the World Commission on Environment and Development (WCED) published its report "Our Common Future" which popularized the term sustainable development (the document more popular as the Brundtland Report after the Commission's chairwoman, Gro Harlem Brundtland)[8]. The definition of sustainable development itself, according to the Brundtland Report, is "development that meets the needs of the present

[7] http://classwebs.spea.indiana.edu/bakerr/v600/rachel_carson_and_silent_spring.htm seen on August 27th, 2006.
[8] http://www.are.admin.ch/are/en/nachhaltig/international_uno/unterseite02330/ seen on August 27th, 2006.

without compromising the ability of future generations to meet their own needs". The statesman has meaning that we cannot exploit the nature when ever we like and use it for our wealth only and left nothing for the next generation. We have to understand that the nature has limitation in recovery after it was exploited and needs long period to make it as original as before. Beside that, most of energy we use now is non renewable and has limited number. So the Brundtland Report asks us to wisely use natural resources because if we use them uncontrolled then soon enough all resources will disappear and we have nothing to support our life. It also asks our consciousness to give equal opportunity and pleasure as we get now to our next generation.

According to the Brundtland Report (1987) in order to implement the idea of sustainable development, there are three sectors that we should consider and conduct in a balance way which are economic, environmental and social. In economic sector, sustainable development motivates every nation and community to be able to produce goods and services consistently to fulfil at least for their own society need (self sufficient). And to achieve this both government and communities are asked to continuously encourage the development of agriculture, industries and other economic activities. In environmental sector, sustainable development asks for every development activity to consider the caring capacity of the environment and avoiding over-exploration of non-renewable resources[9] in order to maintain stability of ecosystem integrity. Sustainable environment must also be able to protect and conserve biodiversity of flora and fauna. And in social sector, sustainable development offers equal opportunity to get jobs, education, heath service, and security for every community and gender. It also gives freedom for every society to express their opinion and motivates community empowerment in every sector of development.

The objectives of the three-dimensional balance can be seen in *Figure II.1* and become the principles of sustainable development. Even though it is difficult

[9] http://facilities.uncc.edu/recycling/Events/Principles%20of%20Sustainable%20Develp.pdf seen on August 27th, 2006.

to achieve what the principles of sustainable development expect and sometimes their implementation is fuzzy and creates conflict of interest (de Roo 2003) but their idea still promises a better future and avoids us from deeper environmental degradation, for instance global warming and acid rain, and social unrest still happen in many places today. Of course they cannot be achieved by only limited parties. They need participation of all members and parts of society, including industrial society. Nowadays, uncontrolled industrial development is suspected as a major source of environmental degradation. Hence, managing industrial development in a sustainable way is an important concern in our development today.

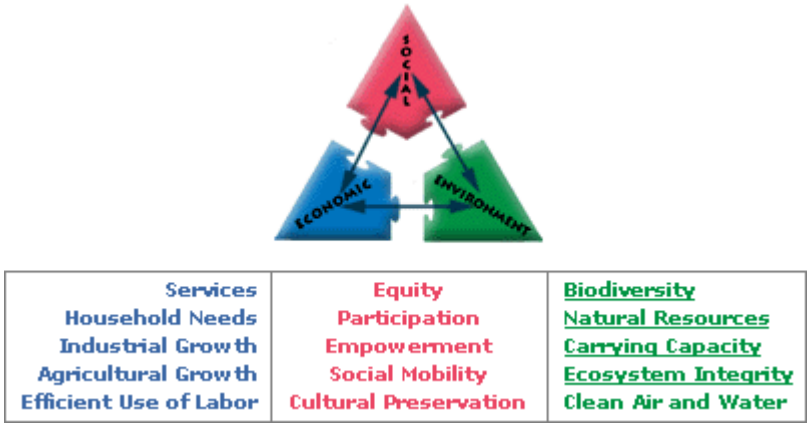

Figure II.1 Sustainable development principles
Source: The World Bank Group (2001)

2.2. Sustainable Industrial Development

From developed countries experiences for years, industrialisation which has been proved, can increase prosperity of a nation. Industry has created bigger productivity of employment than agricultural sector and generates value added incomes[10] which has urged some countries shifting from agricultural to industrial countries. Nevertheless, industry also creates external effect through pollution generation and can absorb or use unlimited resources with its technology which lead to environmental degradation. These contradiction results often create

[10] http://ec.europa.eu/comm/development/body/publications/courier/courier196/en/en_002_ni.pdf seen on August 25th, 2006.

conflict between parties (particularly between economist and industrialist versus environmentalist and communities) and cause a dilemmatic position for government to decide which part should be given the most priorities. These dilemmatic conditions are often experienced by the government in developing countries and the third world as well. Due to most of them are the poor countries, therefore the establishment of industries are expected to create value added income and promote significant contribution to the eradication of poverty[11]. On the other hand, the government also often faces great pressure from the local communities and international organisation to protect environment and enhance production processes performance of industry in their countries. Hence, to the facts it is properly to put industry on the top priority of promoting sustainable development principles.

With the growing interest and consciousness of environmental protection, industries and enterprises in order to be successful operate in the 21st century must meet the need and the expectations of all their key constituents: customers, investors, employees and the greater society[12]. Nowadays, the popular expectation, and sometimes prerequisite, from constituents particularly from customer side is "the consumption and production of more environmentally friendly products by providing consumers with information about their relative environmental impact based on a life cycle analysis" (Jha et al. 1997: 33). Therefore, the implementation of the sustainable development principles in industrial activities becomes an important aspect in business competition strategy. And in order to be sustainable, the overall principles of sustainable development should be applied by industry in its practices and must meet the three requirements outlined below:

- **Economically viable**: in order to be sustaining in the business, industry must be capable to make a profit. The economic viability must be placed in the first

[11] Ibid

[12] http://www.unep.org.bh/Publications/DTIE%20Final/Publication%20Cleaner%20Production%202-04.pdf seen on August 20th, 2006.

consideration when we decide to build business. Even though if our products are produced by an environmentally friendly way but are too expensive for consumer to buy then they are no longer sustainable.

- **Environmentally compatible**: industry in its business should produce the product or service that does not cause any negative effects to the environment as much as possible. Environmentally compatible industry means that it does not only reduce negative externalities but also enhance protection and preservation of wildlife habitat and biodiversity.
- **Socially responsible**: industry has also responsibility to increase communities' prosperity in surrounding areas and maintaining healthy and safety in a work place. By giving equal opportunity to communities to get the jobs then industry can promote social equity and avoid social unrest[13].

Based on explanations above, Staniškis and Arbačiauskas (2003) formulated definition of sustainable industrial development as "adopting business strategies and activities to meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future." It seems that with this definition the win-win solution for the whole parties can be created. Nevertheless, in practices it is difficult to make the need for the enterprise and its stakeholders are in the same line. The enterprise often has opposite goals with its stakeholders. In fact, the members of stakeholders often have different goals. For instance, investors may want to expand their industrial parks to increase revenues while communities want a contrary since they are afraid the level of pollution generating from industrial activities will increase as well and affect their health. Thus, the new formula of industrial development is needed in here in order to stop the conflict and create win-win solution for all parties involved. And the important thing is that the new formula is also applicable to be implemented.

[13] http://www.biobasics.gc.ca/english/View.asp?x=803 seen on August 8th, 2006.

Fortunately, some industries have now become more aware of their responsibilities to protect the environment. With their own consciousness (self-regulation), they start to implement voluntary initiatives to reduce the burden on the environment, shifting from reactive approach to more preventive approach. It is good not only for the environment preservation but also industries and business as a good strategy to attract and fulfil customer needs while creating costs saving. One of the voluntary approaches which can fulfil the idea of sustainable development is Eco-Industrial Park (EIP) (Cohen-Rosenthal 2003). EIP is seen as a visionary approach since it was successfully marrying the previous approaches such as Cleaner Production and Environmental Management Systems and gives equal attention to economic growth, environmental protection, and social equity[14]. It also makes industries in developing countries feasible to adopt since it does not require high technology and a huge amount of investment.

2.3. Defining Eco-Industrial Park

As a new concept, there are many definitions of EIP proposed by researchers but none of them can be accepted as a standard definition. Different type of development projects may propose diverse terms. Nevertheless, in this paper I prefer to use definition created by an Indigo Development team in 1992 as follows:

> *"An eco-industrial park or estate is a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance.*
>
> *"The goal of an EIP is to improve the economic performance of the participating companies while minimizing their environmental impacts. Components of this approach include green design of park infrastructure and plants (new or retrofitted); cleaner production, pollution prevention; energy efficiency; and inter-company partnering. An EIP also seeks benefits*

[14] http://www.indigodev.com/Ecoparks.html seen on August 4th, 2006.

for neighbouring communities to assure that the net impact of its development is positive." [15]

The key word in this definition is collaboration among business to achieve collective and individual goals. This collaboration makes EIP concept different from traditional industrial developments which more focus on individual economic growth and profit and also less concern with the environmental performance. On the other hand, by working together EIP tries to apply strategies of sustainable development by balancing the interest among economic development, environmental protection, and community empowerment.

However, since many academics, researchers or developers use the term of *eco* in different type of development projects such as eco-industrial network, therefore, Lowe (2001: 1) made distinctions that to be a real eco-industrial park a development must be more than:

- A single by-product exchange or network of exchanges;
- A recycling business cluster;
- A collection of environmental technology companies;
- A collection of companies making "green" products;
- An industrial park designed around a single environmental theme (i.e., a solar energy driven park);

With these criteria we can easily differentiate which one of the industrial park projects is included and which is not. Because nowadays, there is a tendency that many industrial park projects claimed their park have resembled as the eco-industrial park. But in fact, their development only implemented one of those criteria.

2.4. The Component Building of Eco-Industrial Park

An industrial park is defined as an area zoned and planned for manufacturing and industrial associated activities, and generally located outside

[15] http://www.indigodev.com/Defining_EIP.html seen on August 4th, 2006.

the main residential area of the city[16]. To attract investors or tenets and to support their activities, industrial parks are located close to inter-modal transportation access such as highways, railroads, waterways, and airports. By grouping together in an area (park or estate), companies share communal facilities so that they can reduce cost to develop infrastructure and other utilities. Types and synonyms of industrial parks include industrial estates, industrial clusters, business and office parks, science and research parks, and so forth. With the appearance of eco-industrial parks concept, now eco-industrial park become part of this list.

In recent years, attention for eco-industrial park (EIP) development projects has grown enormously among national and regional government and industries in many countries particularly in North America (Peck 2002). The idea of EIP was introduced for the first time in Rio de Jeneiro 1992 at the Earth Summit held by United Nations Conference on Environment and Development (UNCED), and from 1993 onwards has become well-known in the USA (Fleig 2000). The eco-industrial park concept is based upon several fields of research and practice that have emerged in the last decade, including industrial ecology, Cleaner Production, and sustainable urban planning, architecture, and construction (see the goal of an EIP proposed by Indigo). These fields contribute to the broader movement to demonstrate the principles of sustainable development in policy and concrete projects.

Industrial ecology and cleaner production emerged at more or less the same time (the late 1980s to mid 1990s) in the evolution of environmental management (Jackson 2002). Industrial ecology seeks to find the appropriate balance between environmental, economic, and social needs of a system. Cleaner Production is a field of research and practice that overlaps with industrial ecology in many ways[17]. Proponents of Cleaner Production and industrial ecology clearly share a breadth of purpose and similar objectives.

[16] http://www.peakagents.ca/glossary/i3.htm seen on August 5th, 2006.
[17] Ibid

2.4.1. Cleaner production

Cleaner production (CP) is the continuous application of an integrated preventive environmental strategy applied to processes, products and services in pursuit of economic, social, health, safety, and environment benefit, and reduces risks to both humans and environment (Jackson 2002). This strategy typically involves the modification of production processes, using a life-cycle approach, and results in meeting customer needs with more environmentally compatible products and services. It is a broad term and some countries or institutions sometimes use different name with more or less the same meaning such as eco-efficiency, waste minimisation, pollution prevention, or green productivity, but it also includes something extra[18].

According to Jackson (2002) at least there are two principles that make Cleaner Production different from earlier environment protection approaches. Firstly, and perhaps the most fundamental distinction, is *preventive environmental management* which requires action to be taken upstream before environmental impact occur. Contradictive to traditional environmental management strategies which tend to clean up pollution after the fact, the prevention looks as far as possible upstream in a network of causes and effects, identifies those elements within the causal network which leads to a particular problem, and takes an action from the source to avoid the problem. Secondly, cleaner production attempts to formulate an *integrated approach to environmental protection*. Unlike traditional end-of-pipe approach which tends to reduce specific environmental emission in different media (air, water or land), cleaner production attempts to avoid this problem by pay attention to emission over the whole life cycle of the product or service from row material extraction through conversion and production,

[18] Ibid

distribution, utilization or consumption, re-use or recycling, and ultimate disposal[19].

To implement the guiding principles, there are two main "operational pathways" for clean production (Jackson 1993, 1996). First, *efficiency improvements* in the system where environmental impacts of processes, product cycles and economic activities are minimized by reducing the material flow. The second operational pathway is through *substitution*, specifically the substitution of non-hazardous or less-hazardous materials for hazardous materials in processes and products. These operation pathways guide us to be aware of the environment and continuous enhance its performance while conducting economic activities. Therefore, from its definition and principles, there are three classes of objectives Cleaner production seek to achieve, which are:

- For *production processes*, Cleaner Production results from one or a combination of conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process
- For *product development and design*, Cleaner Production aims to reduce the environmental, health and safety impacts of products over their entire life cycles, from raw materials extraction, through manufacturing and use, to the 'ultimate' disposal of the product.
- For *service industries*, Cleaner Production implies incorporating environmental concerns into designing and delivering services[20].

On a broader scale, Cleaner Production can help alleviate the serious and increasing problems of air and water pollution, ozone depletion, global warming, landscape degradation, solid and liquid wastes, resource depletion, and visual pollution (Jackson 2002).

[19] Ibid
[20] http://www.uneptie.org/PC/cp/understanding_cp/home.htm seen on August 5th, 2006.

At the policy level, according to Evans and Stevenson (2000), Cleaner Production encourages government to work through five types of instruments for shaping the environmental behaviour of industry:

- *Regulation*, as when the permit of a firm to operate depends on meeting environmental standards, and failure to do so incurs financial or criminal penalties;
- *Voluntary Programs*, such as regulators engaged in an interactive dialogue with firms with an emphasis on sharing and dissemination of information and expertise;
- *Market-Based Instruments*, such as in the use taxes, tariffs, subsidies and other such methods to shift the financial calculations of firms toward environmentally beneficial decisions; and
- *Transparency*, through which public awareness of the dangers of pollutants plus ready access to required reporting by firms on their discharges creates public pressure on the firms to reduce their discharges.
- *Information and Education***,** such as public health education that creates awareness of the risks to human health from pollutants.

From Cleaner Production's characteristics and explanation of its implementation, it seems Cleaner Production offers good solution to solve conflict of interest between environment protection and economic growth. But in practices, it is difficult to be conducted especially for small and medium scale industry which lacks financial capital since Cleaner Production ask investment in advance technology. To make industrial production process as clean as Cleaner Production expected, it need to exchange out date machines for production with the modern one or modified ones. For industry in developing countries where many of their industries are small scale industry even most of them are informal industry, it is difficult to be implemented. Nevertheless, the idea of Cleaner Production has brought a new era for industry, in general, to become part of environmental protection solution. And may be it will be well implemented for big companies which have strong financial capital and human resources.

2.4.2. Industrial ecology

The term of Industrial Ecology has become widespread since 1989 when Robert Frosch and Nicholas Gallopoulos developed the concept of industrial ecosystems in the *Scientific American* (Garner and Keoleian, 1995). Until now, there is no complete consensus on the definition of industrial ecology that is generally accepted since the term is being used at various levels with slightly different meanings. However, most definitions comprise attributes with different emphasis. According to Garner and Keoleian (1995) these attribute include the following:

- a systems view of the interaction between industrial and ecological systems
- the study of material and energy flows and transformations
- a multidisciplinary approach
- an orientation toward the future
- a change from linear (open) processes to cyclical (closed) processes, so the waste from one industry is used as an input for another
- an effort to reduce the industrial systems' environmental impacts on ecological systems
- an emphasis on harmoniously integrating industrial activity into ecological systems
- the idea of making industrial systems emulates more efficient and sustainable natural systems

The primary goal of industrial ecology is to promote sustainable development at the global, regional, and local levels (Garner and Keoleian 1995). Key principles inherent to sustainable development include: the sustainable use of resources, preserving ecological and human health (e.g. the maintenance of the structure and function of ecosystems), and the promotion of environmental equity (both interregional and intersocietal)[21]. Compared to cleaner production which

[21] Ibid

emphasize to process (advanced) technology, industrial ecology is simply focusing on the use or reuse of the waste generated by one industrial process as material input to other process. This concept is based on a straightforward analogy with natural recycling systems where organisms live and consume each other and each other's waste through a web of connections (Jelenski et al. 1992). In their ideal industrial ecosystems, there are symbiotic relationships between two or more industries in which the waste produced by one company would be used as a material or energy input into another. In that way industries would be encouraged to use minimalist virgin material and energy input from outside and no waste would leave the industrial system or negatively impact natural systems.

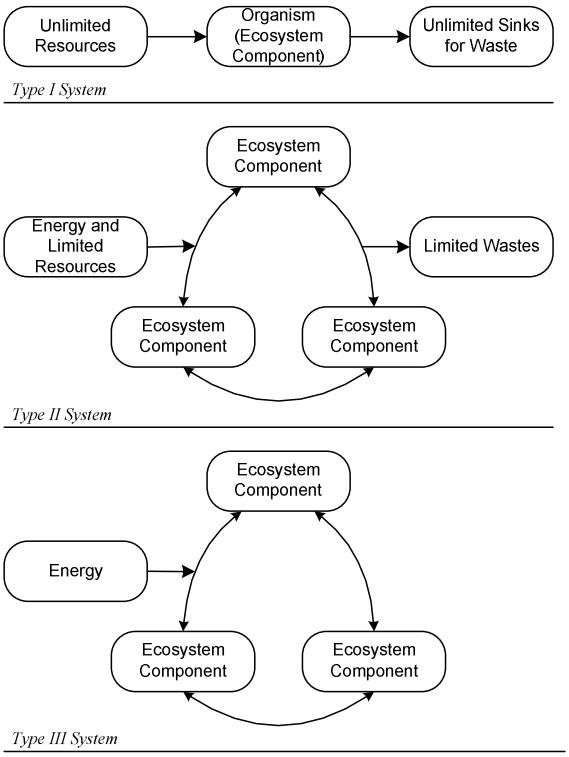

Figure II.2: System types
Source: Allenby (1992)

According to Garner and Keoleian (1995) there are at least four key concepts of industrial ecology: (1) using systems analysis to view and recognize the interrelationships between industrial and natural systems; (2) studying material and energy flows and their transformation into products, by-products, and

waste throughout industrial systems; (3) needing input and participation from many different disciplines; and (4) analogies to natural systems. The natural system has evolved over many millions of years from a linear (open) system to a cyclical (closed) system in which there is a dynamic equilibrium between organisms, plants, and the various biological, physical, and chemical processes in nature[22]. Industrial ecology draws the analogy between industrial and natural systems and suggests that the ultimate goal is to stimulate the evolution of the industrial system so that it shares the same characteristics as described above concerning natural systems. Allenby (1992) has described this change as the evolution from a type I to a type III system, as shown in *Figure II.2*.

A type I system is described as a linear process in which materials and energy flow to one stage of systems and then leave either as product or by-product/wastes (Garner and Keoleian 1995). This type resembles the early ages of industrial development where the supply of potentially usable resources were so large and the number of human habitats were still small then the use of resources did not give an essential impact to the nature (Jelenski et al. 1992). Nevertheless, this system is unsustainable since the number of materials and energy is limited to support the continuous growth of population. A type II system resembles our present-day industrial systems. This type is characterized by the use of high-technology with a certain degree of pollution prevention and waste recycling (Fleig 2000) to process materials and hence more efficient than the previous one. But this type obviously is also not sustainable for long period because there is still some waste is generated. To become ultimately sustainable the system should mimicking biological ecosystem (Jelenski et al. 1992). Biological ecosystem represents the dynamic equilibrium of ecological systems, where energy and waste are constantly recycled and reused by other organisms and processes within the system and highly integrated, closed system (Garner and Keoleian 1995). In totally closed industrial system, only solar energy would come from outside, while all by-products would be constantly reused and recycled within. A Type III

[22] Ibid

system is an ideal goal of industrial ecology that enables management of human activity on a sustainable basis by:

- Minimizing energy and materials usage;
- Ensuring acceptable quality of life for people;
- Minimizing the ecological impact of human activity to levels natural systems can sustain;
- Conserving and restoring ecosystem health and maintaining biodiversity;
- Maintaining the economic viability of systems for industry, trade and commerce[23].

It seems both Cleaner Production and industrial ecology share similar interest in reducing potential pollution but with different approach in conducting it. Cleaner Production is conducting through enhancing performance of production process while industrial ecology through waste or by-product exchange. In the writer's opinion, industrial ecology is more appropriate to be implemented in developing country. It does not need much investment to be adopted. The important thing is building cooperation or network among companies to reuse waste generation. The problem is how to develop cooperation and share same idea with other companies. One of the answers the writer proposes in this paper is through the implementation of EIP concept as it can be seen in the next chapters.

2.4.3. Sustainable spatial planning and design

Another major foundation for EIP development is sustainable spatial planning. Aggregate of resources and materials, and distance-related frictions affect the diffusion of spaces as well as the details of producer and consumer behaviour, industrial location, market areas, innovation rates and settlement patterns (Andrews 2002). Even though technological innovation such as motorized transport and internet have altered but not erased space as an economic

[23] http://www.indigodev.com/IE.html seen on August 6th, 2006.

value. Geography influences and even defines economic and ecological phenomena, and hence an industrial park cannot simply ignore it.

The industrial ecology vision used in EIP development is being implemented at various levels, ranging from macro to micro, and planning practice affects several of them. At the macro level, prescriptive industrial ecology seeks to rationalize aggregate materials and energy flows, which are strongly influenced by settlement patterns. Since many industrial park developments in Asia now include employee housing at or near the site, then sustainable urban planning seeks to integrate land use, transportation, waste treatment, and infrastructure into a unified plan optimizing community use of energy and materials and reducing urban sprawl (Fleig 2000). Local planners can be encouraged to support compact, mixed-use developments that allow residents to substitute walking for driving on some daily trips. While seeking a healthy relationship to ecosystems with reducing aggregate environmental impacts, a sustainable community plan also addresses issues of social and economic equity.

At the meso level, the range of EIP initiatives includes full-scale symbioses, such as industrial parks with shared environmental management infrastructure or facilitates materials exchanges among firms. Firms participating in EIPs – which are planned developments – must comply with both the government's external codes and developer's internal covenants (Andrews 2002). External codes include zoning regulations, historic preservation standards, environmental regulations, building codes and other laws protecting public health and safety such as roles in setting roads, landfills, incinerators, transfer stations, materials recovery facilities and other industrial land uses[24]. At the micro level, EIP development can provide an important opportunity for the newly emerging field of and a laboratory for sustainable industrial facility design and integrating architectural and landscaping innovations with the engineers' new green approaches in infrastructure, plant, production process, and equipment design[25].

[24] Ibid
[25] Ibid

2.5. The Differences between Eco-Industrial Park and other Models

As already stated before, EIP is seen as visionary approach which offers win-win solution not only for environment, economic and society but also for all involved parties. Nevertheless, what factor that makes EIP concept so special and different from other models and worthy to be implemented is a big question that one should consider before implementing it. *Table II.1* shows us at least there are three general types from the perspective of environmental management that we can use to sketch the differences of EIP with other models. Based on EIP definition proposed by Indigo and using *Table II.1* as reference it seems that EIP concept is laid in and shift from process-oriented model to product-oriented model. There are four characteristics that make EIP concept different from other models[26].

First, compared to the other models such as end-of-pipe or traditional models which are more reactive approach in solving environmental problems and usually conducted after they have occurred, EIP concept is more proactive and integrated in managing wastes or by-products generation. Its approach doesn't intend to solve the problems in the endpoints such as cleanup polluted area but does more to solve the cause of problem itself (Jackson 2002). Hence, EIP more focuses on how to enhance the performance of production process and reuse waste or by-product in order to prevent affluent pollution. By continuous enhance effectiveness of production process company will consume less materials and energy and generate minimum waste. Cleaner Production and Environmental Management System are the examples of method that EIP uses in preventing pollution and integrated system of environmental management by involving all involved stakeholder.

Second, contrary with the traditional approach which sees waste as a hazard to health and environment EIP considers waste as a potential economic resource (Sinha 1993). With this vision, EIP tries to optimise the use and value of

[26] Based on own experienced.

material. By recycling and reusing waste, not only cost saving will increase but also potential additional income will rise by selling waste as economic value resource or so called market-driven approach (Cohen-Rosenthal 2003). Of course sometimes the cost for recycling and reusing is bigger than if the waste directly discharges to the final disposal (Daniels and Daniels 2003). But EIP proposes cooperation between companies to solve this problem. By cooperation they can share utilities or exchange waste to be used as materials which in the end will reduce cost for waste management and generate profit enhancement. This is also other distinction between traditional model and EIP concept where in traditional model industry or business works individually and hence cost for waste management is relatively higher than EIP member needs.

Table II.1 Characteristics of three types of environmental management

	End-of-pipe	**Process-oriented**	**Product-oriented**
Focus	Disposal; clean-up	Production process	Product (life cycle)
Type of measures	Relatively simple, technical	Difficult process changes	Changes in the entire product chain
Product or process	None	Process control	Product and process design
Environmental policy/knowledge	No clear policy; not much knowledge	Policy formulation starts; knowledge builds up	Clear policy, much knowledge
Place of environmental management in the organisation	Environmental department	Becomes the concern of other departments	Highly integrated
Relationship environment-strategy	Environmental is not considered	Environment starts to play a role	Environmental concerns are integrated
Regulation and self-regulation	Regulation; firm initiatives are rare	Number of initiatives increase	Many initiatives; more self-regulation
Environmental consciousness	Limited	Increasing	High
Perception of the environment	burden	Precondition	challenge

Source: Adapted (and translated) from Van Koppen and Hagelaar (1998:7) in Kolk (2000:11)

Third, the implementation of the EIP concept is very flexible (Peck 2002) compared to the old model. Company and business can choose the best tool which is suitable with their condition and situation. For instance, companies which face difficulty in adopting Cleaner Production concept because of lack financial capital

to invest advance technology can use other methods such as Good Housekeeping[27] which is simpler and does not need a lot of money to invest new technology. The EIP concept also opens an opportunity for companies to choose type of coordination or network and with whom it will be conducted. With this flexibility company does not feel in under pressure when adopting the EIP concept. Moreover, company can expand its partnership while continuously improving environmental performance.

The *fourth* differences are EIP more as voluntary approach (self regulation) (Cohen-Rosenthal 2003). It is industries or businesses which make first initiative and there is no parties (government or community) force them to implement it. Generally, they adopt the concept of EIP because they believe it will bring many benefits for them through increasing costs saving and create additional income (detail opportunity benefit proposed by EIP will be explained in the next sub-chapter). Beside that, by implementing the EIP concept companies can fulfil requirement legislations (particularly relating to environment regulations) and enhance company and community pride. The effect from this is company has an opportunity to expand its business and open new market (green market).

2.6. Establishing an Eco-Industrial Park

As the field of strategy, exploration for the development of eco-industrial parks is very young and dynamic. There is a very vigorous discussion about a large variety of impulses, proposal and appropriate proceedings. At present, according to Côté and Cohen-Rosenthal (1998) there seem to be two basically approaches in the field work on eco-industrial park:

1. The self-organised system approach that facilitated organic growth (without any overall engineering design) of connection among companies provides

[27] Good Housekeeping practices relate to a number of measures dealing with preventing the loss of raw materials, minimizing waste, conserving water, saving energy, and improving the company's operational and organizational procedures. The implementation of these practices is relatively easy and the cost is usually low, thus they are particularly suitable for managing daily operations within SMEs. Seen at http://www.gtz.de/de/dokumente/en-good-housekeeping-guide.pdf on August 15th, 2006.

better results, as the companies keep ownership of the process and the system gradually develops toward being an organism with its own character. The favourite example of this approach is the first industrial networking model in Kalundborg, a small city on the island of seeland, 75 miles west of Copenhagen, Denmark (Garner and Keoleian 1995; Lowe et al. 1996; Schwartz and Steininger 1997). In the beginning the companies developed spontaneous bilateral waste product exchange partnership in order to reduce waste management cost (Lowe 2001). And after evolvement for over 25 years, this cooperation has made a mutual symbiosis involving many companies and become a model for EIP concept[28] which in the first and on going processed there was neither any intervention nor planning from the developers, researchers or government.

2. The engineered system approach which relies on detailed analysis of data as well as local/regional resource and energy flows. It assumes that once possibilities to maximise efficiency in interaction have been demonstrated, intelligent profit-maximising firms will seek to operate accordingly. In this model, both developers and researchers involved in the very beginning of process and played an important role in analysing materials flows or their life cycle in order to design potential collaboration to reuse waste and develop other mutual partnerships such as joint shipping, marketing or training of employees. The examples for this model can be seen at Brownsville, USA (Lowe et al. 1998); Ecopark Moerdijk, the Netherlands (Heeres et al. 2004); or Fujisawa Factory Eco-Industrial Park, Japan (Côté and Cohen-Rosenthal 1998).

Based on these basic approaches, there are some models that can be used as starting points to develop EIP as can be seen at *Table II.2*. Generally, those models can be divided into two categories which are Greenfield development and Brownfield development. The Greenfield development is a development of new park or estate on the underdeveloped land (green field) proposed in the very

[28] Ibid

beginning for EIP (Fleig 2000). The ex-nihilo model is included in this category. The example for this category can be seen at Part of Cape Charles, USA (Lowe et al. 1998). While the Brownfield development is the redevelopment of the former or existing parks into an EIP to achieve maximum economic growth and environmental protection. The rest models in *Table II.2* are included in this category. The implementation of this category can be seen in the projects of Burnside Industrial Park, Canada (Côté and Hall 1995; Lowe et al. 1998), Recycling Network Styria, Austria (Schwartz and Steininger 1997) or Rietvelden/Vutter (RiVu) sustainable revitalization project, the Netherlands (Heeres et al. 2004).

Table II.2 Starting points for EIPs

Type of model	Approach	Initiators
Ex-nihilo model	Designing an Eco-Industrial Park on a green field and "out of nothing"	Public entity Developer
Anchor tenant model	Identifying an already existing and interested "core-company" and designing Eco-Industrial Park complementing this "anchor" by establishing a network of businesses needed to supply materials and use by-products	Public entity Developer Company
Business model	Attracting a number of tenants in order to develop a certain area and then facilitate network linkages	Developer
Stream model	Analysing different material/resource flows in an existing industrial system and creating a (virtual-) Eco-Industrial Park by networking the users of complementing streams	Public entity Developer Companies
Business-stream model	A combination of the above-mentioned ones: analysing flows in an existing system, networking users and attracting additionally needed businesses to an available development area	Public entity Developer Companies
Redeveloping model	Analysing material and energy flows, communication gaps and possibilities of collaboration in a fully established industrial park, enhancing environmental performance, cleaning up past pollution, presenting possibilities of improvement and facilitating communication and collaboration	Public entity Companies Park management

Source: Lowe et al. (1998) and Chertow (1999) in Fleig (2000: 10)

2.7. Role of Stakeholders

In order to be successful on all fronts (economic, social and environmental), an EIP project needs full support from stakeholders by participating in the whole development process. The role of each stakeholder in EIP project can be seen as follow:

2.7.1. Government

The role of local and central government may intervene at various stages of the development and operation of an estate and may also stand in indirect opposition[29]. In one part, government may act as sponsor of industrial estate development by initiating the project, providing hundreds of facilities on-site and the initiating financing in order to attract business to locate in the estate. It is expected that the development will bring employment and prosperity to the region. On the other hand, government also has responsibility that may contradict with its desire to attract business and investment. Government must continuously monitor and enforce regulations to protect community and environment from any negative effect from industrial activities. Hence, government should produce appropriated and well-adapted policies, planning and legislations which balance between socio-economic and environmental protection.

2.7.2. Developers

Beside government, developers of industrial estates are other powerful players in selecting the sites and financing the development of industrial estates. Although government and local authorities in many countries have their plans and policies to decide which areas are for industrial development and which are forbidden but investors and developers often initiate the development projects based on economic considerations and engineering feasibilities. Developers provide the estate with excellent infrastructure and utilities in order to attract investors as many as possible. Nevertheless, in developing the estate they must

[29] http://www.usaep.org/downloads/archived%20reports/pol_paper_devindest.html seen on August 16th, 2006.

also fulfil any permits and regulations from government and ensure the development of estate does not give any negative effect to environment and communities surrounding area in the future.

2.7.3. Management of estate

Management of estate has three main roles. These are - managing the daily operation of the estate, maintaining the technical services and arranging financing. In the case where the government has set up the estate, the estate management often retains a close relationship to government agencies. Management of estate beside has responsibility to provide service for its tenants and maintain relationship with them estate management has also responsibility to avoid negative effect to community and environment as a result of daily activity of its tenants. In developing EIP concept, estate management sometimes plays as an initiator in order to enhance an image of estate and attract more tenants.

2.7.4. Companies

The tenant companies are present in the estate because they believe that this is where they can maximise their profits. However, they are obliged to comply with the laws of the country in areas such as health, working conditions, worker safety, and environmental impact. In this respect, companies are the main target to control the environmental damage. On the other hand, the environmentally friendly companies request the estate management to provide services and facilities for better environmental performance.

2.7.5. Communities and Non-Governmental Organisations

Local communities are important stakeholders in the industrial estate since they benefit economically through employment and increased economic activity for the region, but may well suffer from the environmental impacts arising from the development and activities of the estate. Communities, or NGO's representing them, are increasingly demanding to be informed about the activities of nearby industrial complexes, whether they are estates or factories. The communities also

play a very important role in awareness and preparedness of responding to technical accidents that may happen in the local area.

2.7.6. Educational institutions and practitioners

The education institutions and practitioners from variety of fields—law, economics, business, or engineering—with the full complement of capabilities are needed to the development of eco-industrial park and the resolution of environmental problems caused by industry. They contribute with researches and assessments and transferring environmentally sound technology will be necessary to rectify an environmental impact.

2.8. Potential Benefits and Treated Risks

The implementation of EIP concept offers some benefits that make industries and business willingness to use it as their environmental management tool and as vehicle to increase the image of both company and community. Some of benefits from industry, environment and community point of view will be presented in sub-chapter below. They show how the EIP concept can give equal benefit to triple bottom lines of sustainable development (economic, environment and society).

2.8.1. Benefits to industry

By implementing EIP concept there are many opportunities will be gained by companies involved. According to Lowe (2001: 2) an EIP offers efficiency companies' production processes through reducing materials and energy uses, and increasing production of high quality products and waste recycling. Beside that, through EIP concept, park or estate members build trusted collaboration among them to achieve greater economic benefit. For instance, companies form by-products exchange network and share common utilities to reuse waste and make them as economic valuable materials. This collaboration indirectly helps companies to fulfil environmental regulations and enhance image of companies as well as the value of parks or estates. By trusted collaboration, other shared

activities such as purchasing, promoting, transporting, educating, and information exchanging can be conducted to create economic efficiency and overcome some barriers that individual companies can not make.

2.8.2. Benefits to environment

From environmental point of view, EIP concept is reducing pollution and waste sources not only in individual plant or park but also in surrounding area and global as well through its innovative methods and technologies such as cleaner production[30], industrial ecology, environmental management system or good housekeeping. With these methods and technologies companies will continuously improve their environmental performance and reduce exploitation of natural resources by optimally using and reusing materials and energy or creating alternative materials and energy from waste generation. In the end, by better resource uses the burden of the environment to provide materials and energy for humankind's activities and absorb pollution will decrease simultaneously and the recovery ability of the environment to make dynamic equilibrium of the entire natural system will increase as well.

2.8.3. Benefits to community

For community, implementation of EIP concept not only offers improvement in environmental performance and quality of life in surrounding area but also create new job opportunity for communities. With its methods such as cleaner production and industrial ecology companies create health and clean environment for communities who live near the park by continuously reducing waste and pollution generation. This healthier environment then will increase park image as well as community leading to attract more new companies invest in parks. The more new companies invest to the park the bigger opportunity for community to get the jobs. The implementation of EIP concept also opens possibility for communities to establish partnership with companies for instance by becoming a supplier of materials or services.

[30] Ibid

Table II.3 Potential benefits of eco-industrial development

Communities	Environment	Business
▪ Expanded local business opportunities ▪ Larger tax base ▪ Community pride ▪ Reduced waste disposal costs ▪ Improved environmental health ▪ Recruitment of higher quality companies ▪ Improved environmental and habitat ▪ Partnership with businesses ▪ Minimise impact on infrastructure ▪ Improved tax base ▪ Enhanced quality of life in areas near eco-industrial development ▪ Improved aesthetics ▪ Good job	▪ Continuous environmental improvement ▪ Better resource use ▪ Reduced waste ▪ Innovative environmental solutions ▪ Increased protection of natural ecosystems ▪ More efficient use of natural resources	▪ Higher profitability ▪ Enhanced market image ▪ High performance workplaces ▪ Improved environmental efficiency ▪ Access to financing ▪ Regulatory flexibility ▪ Higher value for developers ▪ Reduction of operating costs (energy, materials and water) ▪ Reduction in disposal costs ▪ Income from sale of by-products ▪ Reduction of environmental liability ▪ Improved public image ▪ Increased employee productivity

Source: Cohen-Rosenthal (1999) in Fleig (2000, pp.16)

In *Table II.3* Cohen-Rosenthal (1999) summarised some benefit that will be gained by communities, environment and business by implementing EIP concept. And finally "EIPs offer government, at all levels, a laboratory for creation of policy and regulations that are more effective for the environment while less burdensome to business" (Lowe 2001: 3).

2.8.4. Treated risks in EIP development

As already stated before, EIP was the community business which working together to enhance environmental, economic, and social performance by collaborating in the management of environmental and reusing issues. It means that the success of EIP greatly depends on how each member continuously maintains their relationship. Nevertheless, this high level of cooperation and interdependency becomes a major risk of losing a critical supply or market if one or some companies walkout from cooperation or the plant close down[31]. Thus, it is important for every member to manage this relationship by writing a contract insuring reliability of material or energy supply, and keeping in mind other alternative resources (Lowe 2001).

[31] Ibid

There is also a tendency that companies are reluctant to advance their technology and continue reliance on toxic materials (Fleig 2000) since their residual will be used by other companies as energy or materials supply. They assume as long as current technology is still profitable for their process and their waste even still has economic value then it is better to do nothing in order to avoid additional cost. This tendency of course will treat the program of EIP itself which conserves raw materials and energy, eliminate toxic raw materials, and reduces the quantities and toxicity of wastes and emissions like adopted by Cleaner Production concept. Therefore "the pollution prevention solutions of material substitution or process redesign should take priority over trading toxics within an EIP site." (Lowe 2001).

Another risk in implementing EIP projects is sometimes it asks higher development costs compared to the traditional parks, depending upon the design or vision choices in a project. Additional costs usually come from the design process, the site preparation, infrastructure features, construction process, and aspects of building design[32]. In order to fulfil higher standards developers may need a loan in large amount with longer payback period since those facilities are a common use and does not give profit directly to developers or companies.

[32] Ibid

Chapter III
EIP Projects in India, China and Indonesia

3.1. General Conditions of Asian Countries

At least in the last two decades, Asian countries enjoyed the fast economic growth. Thousands, or millions, of industries from developed countries moved to this region to bring advanced technology and prosperity. Some of the factors influencing this situation are cheap productive labours and affluent materials. Most of these companies are export-oriented industries. Nevertheless, informal sector with millions of small and individual enterprises is the biggest sector and has impressive growth in Asian countries. In fact, in some countries this sector is generally considered as a major source of employment generation. According to ILO (2000) 40 to 50 per cent of the non-agricultural workforces are working in this sector in countries such as Indonesia and Malaysia. The collective consumption of materials and energy, and also the resultant problems of pollution and waste in this sector are often larger than in formal sector (Ramaswamy and Erkman 2000). Due to lacking personnel, knowledge, and financial resource, as well as problem in gaining access to information, most those industrial sectors face difficulties to enhance their environmental performance.

On the other hand, even though legislation to promote environmental protection in some of Asian countries is rather progressive by issuing many related environmental regulations but is weak in its implementation. Generally environmental regulations in these countries are imported from developed countries (usually traditional command-and-control regulation) which didn't adapt well to local conditions (World Bank 2000). And in some occasions where there is a conflict between the environmental protection and the need for economic growth, the government usually chose economic first before environment. From

the point of view of the government, generate economic growth and create job opportunities are the most important thing in order to maintain national stability. If a country were wealthy its citizen would get jobs easier. Consequently, its environmental performance would possibly be improved better.

Due to this condition, some peoples believe that Asian region soon become a centre of pollution, sources of disease and environmental degradation. But recent evidence shows a different fact. According to the World Bank Report 2000, factories in some Asian countries are now cleaner than a decade before and their government showed a strong commitment to implement regulations particularly relating to environment protection. For instance, the average urban air quality in China has stabilized or improved since the mid 1980s at the level of 300 $\mu g/m^3$ for TSP (Total Suspended Particulate) [33] concentration while the economic sector continuously grows (World Bank 2000). Beside the growing awareness of the important of environment value to support development, international pressure through World Trade Organisation which has asked for every country and industry to produce their products in an environmentally friendly way is the other factor influencing these changes. Therefore, nowadays many parks and companies in Asian countries have begun to improve their environmental performance. Some of them will be drawn in the next sub-chapter.

3.2. EIP in India—Naroda Industrial Estate (NIE)[34]

3.2.1. Background

Naroda Industrial Estate (NIE) is an industrial estate founded by the Gujarat Industrial Development Cooperation (GIDC) in 1964 located in Ahmedabad in the north-west of India and occupying an area of 30 km^2(von Hauff and Wilderer 2000). Today there are nearly 900 industries located in the estate, most of them are small-scale enterprises, and employed roughly 35,000 people,

[33] Any liquid or solid particles temporarily suspended in the atmosphere. Seen at http://www.bugwood.org/pfire/glossary.html on August 6th, 2006.
[34] Most of data and text in this sub-chapter are adapted from von Hauff and Wilderer (2000), and UNEP (2001.a)

most of whom are unskilled (UNEP 2001.a) A further 40,000 people can be considered to depend indirectly on the industrial estate for their livelihood.

As the largest city in the state of Gujarat, Ahmedabad has played a significant role in the industrial development particularly because it is one of important central textile industry in India. However, in the early 1980's many of the textile mills in Ahmedabad closed and faced serious industrial pollution problems[35]. Hence, it became necessary for the city to diversify its industrial base while continuously enhancing the quality of environment. It achieved this in by promoting an activity in the chemical industry, for example in plastics and pesticides, and in the engineering sector.

Table III.1 Members of Naroda Industries Association

No.	Industrial Sector	Number of Industry
1.	Ceramics, potteries	22
2.	Chemical, paint, dyestuff	220
3.	Electronic and electrical	30
4.	Electroplating	3
5.	Engineering fabrication, steel	130
6.	Guar gum	5
7.	Minerals, pesticides	12
8.	Oil mills	12
9.	Pharmaceuticals	18
10.	Plastics	35
11.	Rice, pulse mills	10
12.	Rubber industries	17
13.	Stationery, allied	8
14.	Textile Mfg, processing	33
15.	Tiles, marbles	5
16.	Wood, furniture	6
17.	Food production	9
18.	Miscellaneous Industries, traders	59

Source: UNEP (2001.a)

There are 18 types of cluster of industries in NIE. Approximately 26% of the industries falls into the chemicals category, predominantly dyestuffs and dye-intermediates[36]. Other types of chemical production are plastics (5%), pharmaceuticals (3%), and pesticides (1%). Engineering (24%), textiles (5%) and

[35] Ibid
[36] Ibid

trading companies (9%) complete the picture of significant industrial sectors within the estate. About 80% of the companies in the industrial estate are members of Naroda Industries Association (NIA) (*see Table III.1*).

NIA is a non-governmental organisation representing owners of companies located within the estate and a proactive organisation concerned with development and local advantages. It has been responsible for a number of projects in the areas of infrastructure, services and environment. To improve environmental quality and as a promotion of the green estate, NIA has planted more than 10,000 trees on the roadside and open space available in surrounding the estate[37]. And since 1994 onwards, NIA has planted more than 40,000 trees.

As a service to the companies' member, NIA has established Naroda Enviro Projects Ltd. (NEPL) as a separate company. The company takes care of problems relating to environment and pollution control by operating a landfill site to manage hazardous solid waste from the estate. NEPL is also in charge to operate the Common Effluent Treatment Plant (CETP) to treat the wastewater from its member companies. It provides a good example how the companies in the estate work together to address the issue of water pollution. With NEPL manages hazardous solid waste and wastewater from the companies, it will improve efficiency of environmental management of the estate. Nowadays, NEPL has treated wastewater from 239 members and manage solid waste of 574 members[38].

3.2.2. Developing vision and stakeholder involvement

In order to enhance environmental performance and fulfil requirement of environmental audit report of State Pollution Control Board to improve resource utilisation and waste management, some of the companies investigated proactive approach which is mainly the Cleaner Production to replace end-of-pipe approaches. The establishment of the NEPL and the success of the new approach to enhance productivity and environmental performance have led to a better

[37] http://www.niaindia.com/aboutus.htm seen on August 6th, 2006.
[38] http://www.niaindia.com/nepl.htm seen on August 6th, 2006.

understanding that some industrial waste still has an economic value after passing recycle process. With this new understanding the companies enlarge the scope of their activity by involving different types of industries to improve resource efficiency and reuse waste which in the end can create additional incomes.

In December 1998, NIA, cooperation with University of Kaiserslautern (Germany) (von Hauff and Wilderer 2000), conducted an eco-industrial networking research project at which the concept of Industrial Ecology was presented along with Cleaner Production strategies (UNEP 2001.a). Several projects ware designed to build collaboration inter and intra-sectoral industries to improve economic and environmental performance of the companies either individually or collectively. This project was also supported by the Local Bureau of the Confederation of Indian Industry (CII) which is one main body in India rising environmental awareness. Researchers from University of Kaiserslautern provided technical assistance and guidance in eco-industrial principles and methods. There was also an MOU between Naroda Cleaner Production Centre (NCPC-A) of NIA and Centre for Environment Education (CEE) to increase environment awareness of the companies members, and NIA has agreed to financially support the project[39].

3.2.3. Planned EIP development

As already mentioned before, the idea of research project is to utilise synergies of industrial ecology networking among the companies towards industrial pollution prevention and using NIA as a channel of coordination. As an initial step, a baseline survey of NIA members was conducted to focus on material, water and energy usage (von Hauff and Wilderer 2000). The goal was to identify common environmental problems as a basis for the development of individual projects for the participating companies. The main objective of the project was to understand the main type of waste being generated by the

[39] http://www.niaindia.com/nepl.htm seen on August 6th, 2006.

companies in the industrial estate and the quantities involved. Other objectives ware (UNEP 2001.a):

- Mapping the different raw materials, power, and water, and also waste streams in the estate, with their quantities.
- Seeking potential links for resource recovery activities by modifying their processes on a regular basis.
- Investigate how to put together partnerships with the different categories of industries within the estate.
- Trying to institutionalise the process in order to make it sustainable.

Using the list of contact person of all member companies provided by NIA, local university graduates interviewed 495 respondents using a questionnaire developed by the University of Kaiserslautern and 477 of them replied it (von Hauff and Wilderer 2000). Data was analysed using a geo-information system (GIS) software to present the data overlay on geographical location. The survey resulting more than 20 possible partnership can be made. During a joint opened discussion, four projects have been nominated for the first phase project implementation and created project teams with managers. The four projects were: (1) recycling of spent acid; (2) recycling of chemical gypsum; (3) recycling of chemical iron sludge; and (4) reuse/recycling of biodegradable waste[40].

In the spent acid project, there are 17 chemical industries producing sulphuric acid and 16 engineering industries which generate mild steel scrap which both of them can be used to make ferrous sulphate, a chemical used in primary wastewater treatment at the CETP (UNEP 2001.a). In addition, there will be another company which was just shut down due to economic reasons to collect and recycle that waste. With this collaboration all parties (chemical industries, engineering industries, CETP, and the procuring company) can make significant cost saving. Other possible partnerships that have been identified in the industrial

[40] Ibid

estate include using spent sulphuric acid in the manufacture of phosphate for fertiliser.

The chemical gypsum project begun when a company discovered that by recovering gypsum it can still be used as materials for concrete production as long as they meet certain specification instead of incurring the costs of transportation and landfill tipping fees. With that information, the three other companies with the same by-product joined the initial project. After passing some recovery processes, their work resulted approximately in 300 tonnes/month of chemical gypsum as materials for cement-manufacturing companies (von Hauff and Wilderer 2000). In NIE, there are other 17 chemical industries which also produce chemical gypsum (UNEP 2001.a). This is potential to create collaboration among them with the cement-manufacturing company. With NIA and NEPL as a coordinator, a proposal has been made for this partnership.

The iron sludge project involves 15 producers of dyes and dye intermediates that generate 350 tonnes/month of iron oxide which are hazardous due to their impurities[41]. Currently it is being disposed off. Thus the first task of the project team is to find a solution to improve the process production which not only decreases but also increases the quality of iron sludge and possibility to reuse it. Through the cooperation of the project team members, they found cleaner production measure is the best solution to the process production and soon enough this experience was distributed to other companies. After the impurities quality of the iron sludge improves and harmless, it will offer possibilities to be used for another process for instance as pigments for brick manufacturing after the reduction of the iron sludge to iron.

Biodegradable waste is produced by nine food companies in the estate, mostly small-scale industry. Even though biodegradable is not categorized as hazardous waste and does not provide any problems to the companies but their accumulation of quantity gives an opportunity to generate energy source and

[41] Ibid

fertilizer. Collectively, those industries generate approximately 10,000 kg of solid material and nearly 90,000 litres of liquid waste[42]. Through a fermentation process, this waste could be used to generate bio-gas as new alternative energy. With this alternative energy, the industrial estate and housing can replace liquefied petroleum gas as energy resource with bio-gas for domestic uses. Beside that, the remains of fermentation process can still be used to generate a high quality fertilizer. A current research for these processes showed that they are economically feasible to be implemented and profitable for a long run of cooperation of the nine companies.

In the second phase of the project, the 15 ceramic industries were examined in laboratory to assure purity of their input materials (Lowe 2001). The possibility to use cleaner production in order to enhance production process performance is investigated. This project will be the fifth project in overall NIE eco-industrial network project.

3.2.4. Benefits and opportunities

Even though Naroda Industrial Estate project is still in early process and no significant result has been recorded but estimation of some potential benefits can be made. In recycling spent sulphuric acid, the chemical companies will pay Rs 200/MT (about US$ 5/MT) for recycling instead of Rs 400/MT (US$ 10/MT) for disposal while the procurer who has already been identified will pay Rs 4/kg (US$ 0.10/kg) instead of Rs 5.5/kg (US$ 0.14), saving him Rs 1.5/kg (US$ 0.04/kg) (von Hauff and Wilderer 2000). The procuring company which is assigned to collect and recycle spent sulphuric acid will provide new additional job for at least 10 persons to run the process. This project is not only creating cost saving and additional income for the companies but also opening an opportunity for community to get a job and better environment.

[42] Ibid

In chemical gypsum project, from economic point of view by reusing chemical gypsum waste it will reduce disposal cost of the 20 chemical companies. While for NEPL, it will create additional income by collecting, processing, and selling chemical gypsum to the cement company. All the processes will also create new job opportunities. From the environmental point of view, there will be 300 tonnes/month of chemical gypsum waste eliminated from dump sites[43]. It will decrease the burden of the environment to absorb hazardous waste.

In an iron sludge project, with cleaner production approach, the 15 dyes and dye intermediates companies will improve their production process performances which lead to reduce production cost and waste minimisation. It will also create health and safety working place which will increase productivity of employees. Beside that, by improving the quality of impurities of the iron sludge, its waste can be used for material of brick production. It means, it reduce hazardous materials thrown away to the environment which possibly create additional income by selling them to brick manufacturing company.

Even though biodegradable waste does not belong to hazardous waste criteria and is not the first priority in NIE project, but with its quantity (approximately 10,000 kg of solid material and nearly 90,000 litres of liquid waste) it will give many benefits including:

- one ton bio solid waste can generate 140 kg of fertilizer,
- this fertilizer contains organic bound nitrogen, which has much more effect on the ground to be treated artificial fertilizer. Thus agriculture only has to use half of the amount of an artificial fertilizer. Therefore, the fermented fertilizer has to be compared to the double amount of artificial fertilizer,
- one ton of biodegradable waste can generate up to 100 m^3 of gas (about 65% methane content),

[43] Ibid

- 1 m^3 of gas has a potential of about 4-6 KW energy (30% electricity, 60% heat at 80^0C-120^0C or respectively 60C coldness)
- Energy can be used for other energy intensive processes such as reverse osmosis in wastewater treatment or for dying purposes[44].

These benefits show not only additional income will be earned by the nine food companies but also reliance of Naroda Industrial Estate in general to particular energy will reduce.

3.3. EIP in China—Dalian Economic and Technological Development Zone (DETDZ)[45]

3.3.1. Background

Dalian Economic and Technological Development Zone (DETDZ) is an independent industrial area founded by the Chinese government in the late 1984 located in the north of Dalian city and under administering the Office for Special Economic Zones of the State Council of the People's Republic of China (the central government agency). DETDZ is the first economic and technological zone in China. Its total area of the zone is 28 km^2 with 15 km^2 being designated as an industrial area (Geng and Côté 2003). There are now 1150 enterprises with over US$ 10 billion investment, including 39 companies that rank among the world's top 500 group, and employed roughly 98,000 workers and managers (UNEP 2001.b).

As a new industrial estate, DETDZ has been equipped with effective infrastructure, convenient transportation and telecommunication systems to attract foreign investment, advance technology and management. It has also been designed for many purposes (commercial, residential, and public areas) and for different types and categories of industries ranging from mega to small-scale industries in order to absorb full employment and strengthen the local economic competitiveness. The business and industry members of the estate cover a range of

[44] http://www.niaindia.com/envior/index.htm seen on August 7th, 2006.
[45] Most of data and text in this sub-chapter are adopted from Geng and Côté (2003) and UNEP (2001.b)

ownership types that include joint ventures, private companies, state-owned companies, and wholly foreign own enterprises (Geng and Côté 2003). The most foreign investments came from Japanese enterprise since DETDZ's geographical location is close to Japan.

DETDZ industrial members are clustered into food processing, electronic appliances, furniture, pharmaceuticals, motors, machine manufacturing, office equipment, chemicals, plastic products and clothing (Geng and Côté 2003). Except Dalian West Pacific Petrochemical Ltd and Dalian Huaneng power plant, most of the enterprises are small or medium sized enterprises with staff numbering from tens to hundreds (UNEP 2001.b).

Table III.2 Import and export companies in DETDZ

No.	Industrial Sector	Number of Industry
1.	Agriculture, livestock	11
2.	Mechanical engineering	32
3.	Chemical, pharmaceuticals	23
4.	Wood, furniture	12
5.	Glass, ceramics, building materials	4
6.	IT, telecommunication	2
7.	Paper, cardboard	2
8.	Textiles, clothing	16
9.	Miscellaneous products	8
10.	Miscellaneous services	40
11.	Food, related products	28
12.	Metallurgy, metalworking	26
13.	Vehicles, transport equipment	8
14.	Rubber, plastics	6
15.	Construction, public works	10
16.	Precision equipment	14
17.	Electrical, electronic equipment	20
18.	Leather, shoes	2
19.	Printing, publishing	7
20.	Transport services	13
21.	Other	45

Source: http://www.dalian-gov.net/enterprise.asp seen on August 6th, 2006.

The DETDZ Administration Commission (DETDZAC) which is responsible for its management of the estate has realized the importance of the environmental performance to attract new investments and to entry the World Trade Organisation (WTO). With its goal "firstly prevent and secondly control", DETDZAC released many environment regulation measures for environment

protection including Environmental Impact Assessment (EIA) and fees for pollution discharge to limited further environmental degradation (Geng and Côté 2003). Due to rapid growth of economic activities and low level of environmental awareness of communities, these regulation measures can not solve all the environmental issues such as solid waste management and water resource shortage[46]. Therefore, adopting a more comprehensive environmental approach is crucial.

3.3.2. Developing vision and stakeholder involvement

In order to discontinue the worsening environmental problems, in October 1998 DETDZAC decided to adopt the concept of Environmental Management System (EMS) according to the ISO 14001 standard (Geng and Côté 2003). An Environmental Management Systems (EMS) is a set of organisational responsibilities, procedures and processes to reduce environmental impacts and increase operating efficiency. EMS includes strategic planning activities, the organisational structure and implementation of the environmental policy as an integral part of the manufacturing process[47]. It is a problem-identification and problem-solving tool to comply with legislation, address stakeholder pressure and improve corporate image and raise awareness of environmental issues.

To ensure efficiency and effectiveness of the implementation of EMS, DETDZAC, as the official agency of Dalian Municipality which is responsible for the daily administration of zone functions, saw it is important to have an organisational framework (Geng and Côté 2003). DETDZAC has appointed the Planning and Construction Bureau (PCB) of DETDZAC to be in charge of environmental protection in the zone. The bureau afterwards has established some offices to implement this function such as an environmental protection office, environmental supervision department and some environmental monitoring stations. There is also an environmental management agent in particular part of

[46] Ibid
[47] http://www.agrifood-forum.net/practices/ems.asp seen on August 6th, 2006.

communities or cluster industries of the zone to keep an eye on the implementation of environmental protection and regulation in low level of the communities and individual plants. *Figure III.1* shows the environmental management system.

Compared to NIE case which focuses on pollution prevention at the estate-level, the development of EIP project in DETDZ was implemented in such a large geographical area (zone-level) and hence it requires an involvement of both the industries and communities. The efficient organisation and the selection of programs are important part in order to harmonize different goals from the companies, communities, and local government. Collaborating with environmental experts from local universities and institution, the DETDZAC set up a specialized EMS guidance group to carry out an internal audit and identified 66 factors affecting the local environmental quality (UNEP 2001.b). Based on that information, the integrated and comprehensive environmental management system was designed to consider the social culture, level of local economic and environmental related policies.

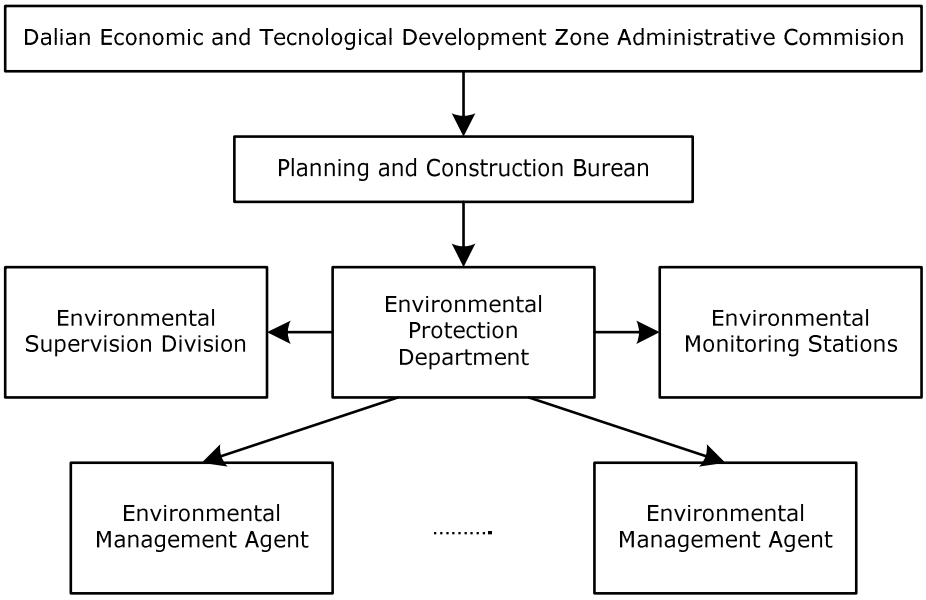

Figure III.1 Environmental management framework in the DETDZ
Source: Geng and Côté (2003)

3.3.3. Planned EIP development

As already mentioned before, the tool to implement the EMS concept is ISO 14001. The ISO 14001 is primarily concerned with the environmental management to help organisations (a) minimize harmful effects on the environment caused by their activities (i.e. cause adverse changes to air, water, or land); (b) comply with applicable laws, regulations, and other environmentally oriented requirements, and (c) continually improve in the above[48]. The scope of the ISO 14001 is flexible. It can be implemented only in a specific operating unit or the entire organisation, or even in more broad area such as in an industrial zone. In an individual business, ISO 14001 encourages the integrated management of input (e.g., resources, raw materials), production process, and outputs (e.g., final product, waste) while in an industrial zone it helps local government in controlling environmental management and improving the environmental management of governmental organisation (Geng and Côté 2003). Although a local government agency may has different value from a company in implementing ISO 14001, but it can be used by the government to help set priorities for addressing an increasingly diverse spectrum of community needs, to establish responsibilities, procedures and policies as well as to verify that its environmental aspects and services are being handled in an effective and efficient manner. The detailed measures adopted by the project group include the following (Geng and Côté 2003):

- Air Emission Control

This program is in line with municipality program "Blue Sky, Green Sea Project" to protect local natural environment, promote the local residents' living conditions and increase the city's competitiveness (UNEP 2001.b). The programs include:

  - replaced coal with liquefied petroleum gas (LPG) for domestic consumptions to reduce sulphur dioxide emission and dust from coal burning;

[48] http://en.wikipedia.org/wiki/ISO_14000 seen on August 6th, 2006.

- replaced the boilers below one ton with the bigger one to improve energy efficiency and reduce air emission of district heating; and
- strengthened the monitoring and enforcement of control emission from vehicles.

- Integrated Water Management

Water scarcity is a critical issue faced by Dalian city. In order to solve this problem and manage the water supply properly, DETDZAC adopted integrated water management approach. The step of this project was conducting a zone wide water audit and identified key water users and some key water leakage points (Geng and Côté 2003). Then DETDZAC has constructed two sewerage treatment plants with its capacity 140,000 tons/day to treat wastewater before discharge into ocean (UNEP 2001.b). DEYDZAC has also purchased another purifying wastewater treatment facility and installed a new water pipe to deliver the remains of the treated wastewater so it can be used as cooling water for the local power plant and watering public garden. Another scheme implemented by DETDZAC was applying a water quota pricing systems where residential users must pay 10 times the regular rate for their extra use and 20 times for industrial users (Geng and Côté 2003). With this scheme, the communities and companies are encouraged to use water wisely and implement water reuse and wastewater minimization. And other schemes such as stipulated a new policy to control the waste discharge from ships and marine culture, monitored the emission of sewerage, and promoted the use of phosphate free detergents are also conducted by DETDZAC as part of integrated water management project (UNEP 2001.b).

- Integrated Solid Waste Management

Solid waste management is one of critical environment issues for Dalian municipality as well as the industrial estate. To solve this problem, DETDZ adopted an integrated solid waste management approach which covers industrial solid waste management and municipal waste management (Geng and Côté 2003). Relating to industrial solid waste management, a modern private solid waste company, Dongtai Industrial Waste Treatment Company, has been established

under the supervision of the government (UNEP 2001.b). To treat the entire dangerous solid waste, the company constructed a hazardous waste landfill and a liquid waste incinerator. The establishment of this company with its advance technology will reduce the government burden in managing waste. Another industrial solid waste management is relating to fly ash and bottom dust from the local power plant[49]. The approaches to solve this problem are installing a new desulphurisation and filter facilities on the chimneys of the power plant and reusing that waste as raw materials for brick and asphalt productions. To solve municipal solid waste management, the government enacted a new regulation which compels the communities to use plastic bags to contain their domestic garbage before it is delivered to the final disposal landfill to avoid non-point pollution during its transportation (Geng and Côté 2003). In addition, to promote waste minimisation program the communities ware asked to categorize their domestic garbage into organic and non-organic waste in order to reuse or recycle the waste for other uses.

- Promoting Cleaner Production and ISO 14001 Standard Certification among the Local Enterprises

In order to ensure the successful of EMS program, the management estate and the local Environmental Protection Department (EPD) actively promoted cleaner production according to the ISO 14001 standard among the companies. Cleaner production is seen as an effective approach to eliminate industrial waste and enhance efficiency of production processes rather than the end-of-pipe approach. The local EPD with a help of external environmental experts collected documents and information on cleaner production and provided free consulting services for the companies (Geng and Côté 2003). On the other hand, to encourage the companies eager to register their companies and pass ISO 14001 certification, DETDZAC provided a subsidy for up to 50% consulting and certification fees (UNEP 2001.b). Moreover, the local Planning and Construction also supported this program by provide comprehensive environmental

[49] Ibid

management services by disseminating relevant environmental laws, environmental management case studies and information on environmental technologies (Geng and Côté 2003).

- Awareness and Preparedness for Emergencies at the Local Level (APELL)

With the high frequency of operation within the industrial estate such as transportation and material handling, storage and disposal of industrial chemical, the probability of industrial incidents happens is also high. Hence, in order to prevent such incidents, the local EPD with the help of UNEP's experts initiated its APELL program in 1995 (UNEP 2001.b). The APELL program is designed to identify and create awareness of risks in an industrialised community, to initiate measures for risk reduction and mitigation, and to develop coordinated preparedness among the industries, local authorities and local communities[50]. The DETDZ's APELL program includes the following (Geng and Côté 2003):

- Identify potential hazards and responsible companies and persons.
- Review the current emergency plans, change unreasonable plans as necessary, and integrate all the plans into an overall plan.
- Educate and train the stakeholders about hazardous materials management and emergency preparedness.
- Provide the resources needed to respond to emergencies.
- Establish procedures, review, update, and obtain the local government's approval.
- Recruit more qualified and professional employees to deal with natural disasters, such as typhoons, earthquake and floods.
- Update the Geographical Information System (GIS) to monitor the zone's potential hazardous site.

Beside those programs, DETDZAC has also promoted other programs such as forest management and biodiversity conservation, environmental education, and urban greening (UNEP 2001.b). All of those programs showed the seriousness of

[50] http://www.uneptie.org/pc/apell/ seen on August 7th, 2006.

DETDZAC in improving environmental quality in the industrial estate as well as surrounding area.

3.3.4. Benefits and Opportunities

After a couple of years implementing the environmental management system, it has brought many benefits to DETDZAC. Some of them are:

- Improving the environment investment

The implementation of the ISO 14001 standard has made DETDZAC continue to improve the quality and standard of infrastructure and utilities in DETDZ. This condition makes investors and tenants willing to increase their investment in the estate. For instances, Kaijin Chemical Company has increased their investment by 500 million RMB in order to expand their business and Daimler-Chrysler Motor Corp. also to plan to invest US $150 million to manufacture engines in Dalian (Geng and Côté 2003).

- Promoting more enterprises to establish an EMS according to the ISO 14001 standard

Even though ISO 14001 is a voluntary standard but it offers many benefits to implement. For instances, it will create a cost saving and an open new market, particularly a green market. Hence, in the year 2001 alone, with a subsidy from the EPD, over 100 tenants preparing to establish an EMS according to the ISO 14001 standard and 33 of them have passed the ISO 14001 certificate (Geng and Côté 2003).

- Improving the local environmental quality and protecting natural resources

The establishment of EMS program has quickly improved the environment quality in DETDZ by reducing air emission, wastewater pollution and solid waste generation. For example, under the Air Emission Control program, the conversion rate from coal to liquefied petroleum gas has reached 98% (before the implementation of the program, the rate was only 68%) which has helped reduce the emission of sulphur significantly (Geng and Côté 2003). The other direct

outcome is that in the year 2000 Total Suspended Particulates (TSP) was reduced by 46.5%, sulphur dioxide was reduced by 16.7%, COD was reduced by 13.2%, and NOx was reduced by 9.1% using 1999 as the reference year (Environmental Protection Office of DETDZ) (UNEP 2001.b).

- Reducing pollution accidents and environmental risks

The implementation of APELL program as emergency response procedures to prevent technological incidents and to reduce their impact when they occur has reduced environmental risk and increased public's awareness, health and safety. Other extended benefits from this program are a habitat recovery, an increase in morale of the staff, and reduce operation cost (Geng and Côté 2003).

3.4. EIP in Indonesia—Lingkungan Industri Kecil (LIK)[51]

3.4.1. Background

Lingkungan Industri Kecil (LIK) is an industrial estate founded by PT. Tanah Mas Group in 1979 occupying an area of 1 km^2 and situated in the north-east part of Semarang, Indonesia (UNEP 2001.c). The estate operated and managed by PT. Tanah Makmur which is subdivision enterprise of PT. Tanah Mas Group. LIK Industrial Estate is the first private industrial estate in Indonesia. From the beginning of development, LIK has been fully supported by the Department of Industry through facilitating all licence matters (companies which will invest in LIK do not need to obtain any permits from the Department of Industry) and providing information of new policies, legislations, and strategies to both the industries and management.

Similar with the meaning of its name "environment for small-scale industries", LIK was developed to accommodate small- and medium-scale enterprises to run their business in better location. Its location which is close to the city centre (6 km from Semarang city) and supported by major form of

[51] Most of data and text in this sub-chapter are adopted from UNEP (2001.c)

transportation such as a highway, railway, seaport, and airport to enhance the competitiveness of LIK and make it as a strategic industrial estate for Semarang. Nowadays, there are nearly 480 companies located in the estate with mainly small-scale industry, and employed roughly 25.000 people with low pay[52].

Table III.3 Listing of companies by sector in LIK

No.	Industrial Sector	Number of Industry
1.	Food, beverage	62
2.	Car workshop	25
3.	Services	52
4.	Paint	13
5.	ACCU, SPIRITUS, ALCOHOL	10
6.	Paper, stationery	41
7.	Printing	39
8.	Electronics, electrical	8
9.	Ceramic, metal	34
10.	Mechanical engineering	7
11.	Furniture, wood	33
12.	Footwear	5
13.	Plastics	30
14.	Textile	4
15.	Household equipment	30
16.	packaging	4
17.	chemicals	24
18.	Poultry	3
19.	Construction	24
20.	Cosmetics	2

Source: UNEP (2001.c)

As its management of LIK industrial estate, PT. Tanah Makmur took responsibility for the infrastructure on the site such as building the roads, pipelines, other common facilities such as a show room called "Graha Pariwara" (Chiu 2001) where the companies are located within LIK can use (without any charges) to present their products to potential customers. PT. Tanah Makmur also tries to help the companies which face lacking capital with a soft loan program where loan can be paid back over a long time period (15-20 years) (UNEP 2001.c). Even though there is an industry association, called HIPLIK (Himpunan Pengusaha LIK), but it is not as influential and very active as NIA in India case.

[52] Ibid

LIK industrial estate was developed on marshland which has been reclaimed. As part of the land lies below sea level, the estate gets easily flooded during heavy rains because the water cannot be discharged quickly although the government has built dykes to prevent it. LIK industrial estate also faces serious industrial pollution problems, particularly wastewater. It is because both LIK management and companies do not provide themselves with effluent treatment plant to treat the wastewater. The environmental regulation enforcement is also not entirely accomplished (small-scale industry is not obligated to have wastewater treatment). As a result, water pollution from the estate contaminates the surrounding area, causes water quality degradation and derivation of farm productivity.

3.4.2. Developing vision and stakeholder involvement

In order to overcome industrial pollution problems, in 1997 the management of LIK industrial estate (PT. Tanah Makmur) started to introduce environmental management and investigated the possibilities for creating eco-industrial networking amongst its tenant companies (UNEP 2001.c). Collaborating with the University of Kaiserslautern (Germany) and the University Dipenogoro in Semarang, they have decided two pilot projects: biowaste treatment and good housekeeping[53].

In the first phase, the project examined the possibility to build networking involving some of companies as a pioneer for a cooperative approach with the management estate as coordinator. If the cooperation shows positive improvement then the project will be extended by involving the whole member of the estate. By working together with one another, the project does not have to rely on a consultant. It is hoped that this will establish strong links and a level of trust among companies as well as with the management estate in order to address environmental management at an estate-level.

[53] Ibid

3.4.3. Planned EIP development

As already mentioned before, during joint discussion in the first phase, the pioneer group has nominated two projects:

- Biowaste treatment. The general idea of the biowaste project is to make use of the biowaste that is generated in the industrial estate—and possibly also in the surrounding urban settlements—and in the water hyacinths to create valuable resources such as energy or fertilizer.
- Good Housekeeping. The idea of this project is to introduce the Good Housekeeping (see Chapter 2 for explanation) Module of GTZ[54] to the companies within LIK to achieve three win organisation aspects (reduce production cost, improve overall company's productivity, and lessen a company's environmental impact) and also allow for more easily attaining ISO certification of any type. Good Housekeeping cover six areas: (1) efficiently using raw materials and supplies; (2) managing waste responsibility according to the 5Rs (Reduce, Reuse, Recover, Replace, Recycle); (3) assuring logistics to effectively handling and transferring materials and products (especially for hazardous waste); (4) saving water; (5) saving energy; and (6) improving safety of the staff[55].

The success of this initial project with limited number of companies is very important to increase environmental consciousness of the companies within LIK. However, due to Asian economic crisis in 1997 where many industries collapsed, almost all sound environmental programs were suspected as additional cost by the companies and prevented them from participating. Thus the first task of the estate manager is going to overcome some of the typical barriers such as:

- The belief that solutions to environment problems always cost money rather than being the source of potential benefits.

[54] GTZ: Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Technical Cooperation)
[55] http://www.sba-int.ch/GHK.htm seen on August 7th, 2006.

- The desire not to share or release company information because of the fear that competitors will copy their processes, or that the government will prosecute them for wrongdoing.
- A lack of awareness on the environmental issues within the company.
- A lack of human resources (UNEP 2001.c).

Although the project is still at planning stage for this eco-industrial networking, two examples of networking activities involving the estate manager are already occurring in the estate:

- the estate management group provides a show room, called "Graha Pariwara", for all of the tenant companies to display their goods and share marketing, and
- the estate management group is also often called upon by tenant companies asking supply information of manufacturers or distributors of raw materials[56].

These networking activities give positive atmosphere to enhance cooperation among companies. The function of Graha Pariwara can be extended not only as media for promotion of products and marketing but also media for information exchange of pollution prevention programs in individual plants. On the other hand, the estate management can use information of supply and materials to design other possibly by-product networks.

In order to maintain environmental management, the estate management provides containers to be placed in each lot to receive all types of waste and will be collected by scavengers every day performing the traditional waste recovery by manual segregation. Some useful recyclable materials are sold or re-processed such as paper, plastic and carton box. In addition several companies are located within the LIK estate dealing with lead batteries and glass. Three battery recycling factories receive used batteries from collectors and then separate the individual parts of the battery to be sold. Bottles and all types of glass are also collected by the scavengers who work inside LIK. They then sell the glass to bigger collectors. These recycling companies separate the glass and sell it back to the glass or bottle factory.

[56] Ibid

3.4.4. Benefits and opportunities

Even though this project is still in an initial phase but some potential benefits can be estimated. In the biowaste treatment project, from economic point of view by recycling biowaste, it will not only reduce disposal cost the 62 food and beverage companies but will also create additional income by transforming biowaste to become high quality fertilizer of new alternative energy. While for the local government, it will decrease the cost for the municipality waste management. From the environmental point of view, the recycle project will decrease the burden of the environment to decompose hazardous waste and increase water quality of surrounding area which at the end will also rejuvenate the farm productivity.

In a good housekeeping project, it will help the companies calculate and estimate environmental costs and save in order to evaluate:

- the potential savings of reducing resource use and reducing waste;
- the investment and running costs required to use materials, waste, and energy in a more sustainable manner; and
- how to allocate the cost of waste treatment and disposal to operations that generate waste rather than to the companies' general expenses[57].

With this project, the companies have an opportunity to look closer into their operation and identify further opportunities to optimise the production process, use resources more efficiently (raw materials, etc.), close flows of materials and substances (through reusing/recycling), and address economic and environmental weak spots[58].

A good potential of the estate is that management provides the showroom for shared marketing. This can be the further eco-industrial network activities such as information exchange of by-products, enhancing government-industry cooperation, or setting up of a cleaner production advisory centre. By integrating

[57] http://www.sba-int.ch/GHK.htm seen on August 7th, 2006.
[58] Ibid

the first pilot projects, even though they are still in planning phase, it will allow the estate manager to extend environmental management within the estate in order to reduce its environmental impact and attract new investors. And for communities, they will have healthy neighbourhood and good job opportunity.

Chapter IV
Analyses of Cases Studied

4.1. Push and Pull Factors

From the explanation of Chapter III, all projects share similar factors that influence both companies and developers or management to implement the concept of eco-industrial park. One of them is a difficulty to fulfil environmental regulations if they work individually. Most industries in the three cases reviewed are small-scale enterprises and have limitation—on the amount of finance, technology or expertise—to improve technological capabilities in the processes, productions and waste management. Even though companies individually enhance their environmental performance, it does not mean that every estate has high quality environment if others do not wish to do so. Due to those limitations, small- and medium-scale enterprises might prevent to participate in the EIP project unless there are sponsors or third parties that provide them with financial services. For instance, in the china case, the government must provide subsidies for up to 50% in order the companies pass ISO 14001 (Geng and Côté 2003). Without them that the small- and medium-scale industries are reluctant and unwilling to adopt ISO 14001 since it requires high cost.

Other factor is the companies and estates are experienced in a state of decline in export and profit margin. Nowadays, with regard to high interest of environmental awareness, there is a tendency that consumers and global markets prefer using "greening products" as prerequisite to business relationships. It means from the beginning the product should be produced in an environmentally friendly way. There is also tendency that consumers favour to purchase products from companies using recycle materials (Daniels and Daniels 2003). This condition forces industries in the three case studies to advance their processing technology or at least enhance their environmental management systems to accomplish costumer preferences, particularly costumers from Europe and North America.

Beside that, the prices of materials and energy continuously raise-up and make industries difficult to meet efficient production costs. They need to change their out-date technologies with new ones to ensure the factories run efficiently and also find other types of

materials and alternative energy which have now become more scarce and expensive. And the important part is finding other income resources in order to ensure existence of the companies.

To meet these demands, the companies as well as developers or managers estates need to shift their traditional system to a more visionary concept. The concept that can attract new investors as fresh blood to rejuvenate their estates' development phase and the concept that can help the companies improve their environmental protection whilst at the same time they build business competitiveness. The eco-industrial park (EIP) concept then becomes part of solution for those parks or estates of the cases studied. The goals and benefits proposed by EIP (see Chapter II) are the significant pull factors influencing the companies and developers to choose this concept.

4.2. Characteristics of the Cases Studied

Table IV.1 presents the most important features of the three EIP cases studied. It shows that Naroda Industrial Estate (NIE) has the biggest area while Dalian Industrial Park (DETDZ) has the most company's members. On the other hand, even though Lingkungan Industri Kecil (LIK) has the smallest area with less members but is the most densely compared to others. The data also reveal the status of ownership from the three cases studied where NIE and LIK are privately-owned while DETDZ is public owned. As a public-owned industrial park and designed as economic and technological development zone with the aims to attract foreign investments, DETDZ has more advance infrastructure and utilities compared to the two counterparts and gains full support from the central and local government. Beside that, strict implementation of regulations is the other factor that makes the management of DETDZ easier to implement EIP concept. On the other hand, even though NIE and LIK are privately-owned but they have different parties in managing estates. NIE is managed by the industrial estate association (Naroda Industries Association [NIA]) while LIK is managed by the developer PT. Tanah Makmur. These two management estates are very concerned with the development of infrastructure and other common facilities although it seems the performance of NIA is better than PT. Tanah Makmur. It can be seen from how NIA provided the estate with a common effluent treatment plant and founded the Charitable Hospital and bank.

Table IV.1 Important situational feature of the selected EIP projects

Characteristics	Naroda Industrial Estate	Dalian Industrial Park	Lingkungan Industri Kecil
Location	Ahmedabat, India	Dalian City, China	Semarang, Indonesia
Established	1964	1984	1979
Size (km^2)	30	15	1
Companies	900	1150	480
Status	Private owned	Public owned	Private owned
Initiated	1998	1998	1997
Starting point for EIP Approaches	Anchor tenant model Utilise synergies of industrial networking toward pollution prevention	Ex-nihilo model Establish comprehensive environmental management system according ISO 14001	Stream model Improving better resource use toward good housekeeping program

Table IV.1 also reveals that NIA and LIK projects are Brownfield remediation programs which mean the former or existing parks are redeveloped into an EIP to achieve maximum economic growth and environmental protection. They can be seen from the time the estates had been established long before the EIP projects were initiated. On the other hand DETDZ project is included in the Greenfield development category since it was designed with multi purposes (commercial, residential, and public area) and most environmental standards and regulations have been fulfilled. DETDZ is also equipped with better infrastructure and common utilities.

From the initiation of EIP plans and approaches of point of view, the three estates share different types of models. NIE used anchor tenant model as a starting point to implement the EIP concept. It can be seen from how NEPL (Naroda Enviro Projects Ltd.) and CEPT (Common Effluent Treatment Plant) play a central role in helping the companies to reuse or recycle their industrial waste and propose some networking among them. By using material flow analysis[59] method to identify the life cycle of materials and energy, not only the potential by-products exchange networking among member can be made but also a new market in certain area and exchange information can be created and at the same time solutions to the environmental protection can be promoted.

On the other hand, by adopting the principles of comprehensive management system according to the ISO 14001 standard, DETDZ tried to harmonize the different goals among the companies, communities, and local government. Every stakeholder was involved in this project including communities' participation in a surrounding area. By carrying out an

[59] Material flow analysis is an evaluation method which assesses the efficiency of use of materials using information from material flow accounting. Material flow analysis helps to identify waste of natural resources and other materials in the economy which would otherwise go unnoticed in conventional economic monitoring systems. Seen at http://glossary.eea.europa.eu/EEAGlossary/M/material_flow_analysis on August 10th, 2006.

internal audit and identifying factors affecting environmental problems many programs are designed such as cleaning up past pollution, urban greening and environmental education.

Other model, stream model, is used by LIK to implement the EIP concept. Using biowaste and Good Housekeeping as pilot projects, LIK tried to solve environmental problems at the plant level first and created networking to reuse or recycle wastewater. By analysing material and energy flows using good housekeeping guidance, the companies are able to demonstrate improvement in their operational and organisational procedures. Good housekeeping is suitable to be implemented in LIK where most of its company's members are small- and medium-scale enterprises (SMEs) since it is less complicated, easy and inexpensive.

4.3. Objectives

From *Table IV.2* we can see different objectives from the three cases discussed and the literature studied. In NIE case, the project shared equal interest on both environmental and economic reasons. This can be seen at how the project conducted material flow analysis and life cycle assessment[60] to identify a wide variety of different types of waste and then differentiated commercial and non-commercial waste. Waste with commercial values can directly be reused or sold, while non-commercial waste, particularly which was currently being dumped, should be re-processed or transformed to become commercial waste. Thus it becomes an important part to build coordination amongst competent companies to deal with waste and build networking with potential consumers. By transforming non-commercial waste becomes valuable materials or energy, it will gain not only environmental protection but also economic benefit.

On the other hand, the first objectives DETDZ and LIK projects seem to promote Cleaner Production and clean up past pollution. The Good Housekeeping program and air emission control program are two examples of cleaner production at plant level conducted by LIK and DETDZ while biowaste treatment and integrated solid waste management are the examples of clean up past pollution program. Not like NIE which conducted material flow analysis to search possibilities to reuse or recycle non-commercial waste and actively created a new market for them, LIK and DETDZ tended to apply the pollution prevention approach to

[60] Life cycle assessment is a tool for the systematic evaluation of the environmental aspects of a product or service system through all stages of its life cycle. Life cycle assessment has proven to be a valuable tool to document the environmental considerations that need to be part of decision-making towards sustainability. Seen at http://www.uneptie.org/pc/pc/tools/lca.htm on August 10th, 2006.

solve pollution or waste problems, for instance by implementing water quota pricing systems which compel the industries in china case to pay 20 times more than a regular price for extra uses (Geng and Côté 2003). Even if there is by-product exchange but the number is still limited with minor deep analysis to improve their use for next life cycle. Nevertheless, with their planned programs, DETDZ and LIK are trying to build access for greening market.

Table IV.2 The comparison between theory and EIP practices at the three cases

	Theory	**NIE**	**DETDZ**	**LIK**
Objective				
EIP as an environmental project	+++	+++	+++	+++
EIP as an economic project	+++	+++	++	++
Stakeholder involvement				
Involvement of local/regional government	++	++	+++	++
Involvement of national government	+	+	+++	+
Involvement of developer and management of estate	+++	++	+++	+++
Involvement of local entrepreneurs' association	++	+++	0	+
Involvement of local industry	+++	+++	+	++
Community involvement (residential) and NGOs	+++	0	+	0
Educational institution involvement	+++	+++	+++	+++
Potential areas for improvement and networking				
Production process	+++	+++	+++	++
Materials	+++	+++	+++	+
Energy	+++	++	+	++
Marketing	+++	+	+	+++
Transportation	+++	0	0	0
Human resources	+++	+	+++	+
Environment/health/safety	+++	++	+++	+
Quality of life/community connection	+++	0	+++	0
Information/communication systems	+++	++	++	+

Legend: + indicate well performance; ++ indicate good performance; +++ indicate better performance; and 0 indicate indifferent performance

4.4. Stakeholders Involvement

The involvement of stakeholder in the three cases studied show different characteristics. In DETDZ case, the government, both central and local, played as an initiator in this project. Its involvement is easier to understand since the estate was developed and managed by the government. In centralistic countries like China, all industrial parks are public owned. The role of government becomes an important part to ensure the success of projects. Therefore the local companies remain passive throughout the project and rely on the support from the government (e.g. subsidies 50% from the government in order the companies pass ISO 14001).

The similar situation is also faced by LIK where management estate took an initiation to run the project. In the planning stage, the local companies had less interest to participate

since they did not seem to be aware much of the environmental issues and believed that the solution for environmental problems always asked additional cost (UNEP 2001.c). Thus selecting appropriate programs then become an important matter to attract participation of the companies. Good Housekeeping program proposed by the management of the estate seem successful to attract companies to participate since it offers many benefits for the companies, for examples: preventing the loss of raw materials, minimizing waste, conserving water or saving energy. On the other hand, the local entrepreneur's association of NIE plays as an initiator of the project. The local entrepreneur's association has close relationship with central and local government and always coordinate its action with them. The project got full support from the local industries actively. They shared vision and ideas in every stage and at various groups of project to find a best solution and proposed equal benefit for every member. Active participation then becomes an important factor to influence the failure or success of projects.

The important note at all the projects is they lacked local communities and NGOs involvement. The communities and NGOs are not encouraged to participate on the planned projects by giving their ideas and opinion even though they are part of projects' object. It seems the initiator projects only focus on the companies, direct stakeholder involvement and education institutions (both international and local). Unlike NGOs and communities, education institutions became an important part in the development process of all projects. They contributed by doing baseline survey to identify and assess factors that affected the environment quality and analysed material flows to improve production process and operational performance of individual plant and to create networking between companies. They also played as consulting agencies by providing guidance, technical assistance and giving training and educating to relevant stakeholders.

4.5. Potential Areas of Improvement and Networking

By comparing the theory with the practices, *Table IV.2* indicates the three cases studied have different results in creating potential areas for improvement and networking. The selected approaches and proposed programs are the factors that influence them.

- Production process

In the production process area, the performance of NIE and DETDZ shows better result than the one of LIK. At least there are three areas in production process that NIE and DETDZ projects can improve: pollution prevention, scrap reduction and reuse, and common

subcontractor. In NIE case, pollution prevention is implemented in the iron sludge project by identifying the possibility to improve production process and continuously reducing the quantity of iron sludge. The remainder waste after passing recycle process to make them harmless can be used as materials for brick production and asphalt. In another project, beside reusing waste for the next cycle, for instance reusing spent acid (H_2SO_4) by mixing with different source to generate ferrous sulphate ($FeSO_4$) or recycle chemical gypsum for material cement production, they also share common subcontractor to collect their waste to be recycled. With this cooperation all parties can make significant costs saving.

In DETDZ case, there is a policy that compels industries to pay 20 times more than regular price for their extra uses which is so called water quota pricing system. With this system industries are encouraged to minimise wastewater activity and reuse it. Another pollution prevention activity is to install a new desulphurisation and filter facility in the smokestack of the local power plant to reduce sulphur dioxide and dust emission. The remainder desulphurized flying ash and bottom dust can be reused as raw materials for brick productions. While Dongtai Industrial Waste Treatment Company acts as a common subcontractor which safely disposes of all the dangerous solid waste for industries located within DETDZ.

In LIK case, Good Housekeeping program encourages individual companies to prevent the loss of raw materials and energy, and improve companies' operational and organisational procedures. With this program LIK conducts pollution prevention approach at the plant level. There is also an area to scrap reduction and reuse biowaste and water hyacinths that transform a high quality fertiliser. This activity does not only reduce biowaste but also makes it commercial value waste.

- Materials

Similar to production process analysis, the result of materials improvement shows that LIK creates less improvement compared to the two counterparts. It seems that the improvement in production process will create improvement in material area as well. The important factor limiting this improvement is the number and size of companies located within LIK which is not suitable to conduct by-product exchanges. To make the cooperation of by-product exchange economically feasible, the quantity and quality of waste generated by each participant companies should meet particular requirements and there should be a

guarantee for continuity of supply as well. These conditions are difficult to be met by the companies within LIK since they operate in small an area with limited materials and finance.

Nevertheless, in LIK case, there is still a possibility to make by-product connection through recycling biowaste among the food companies and create new market for fertilizer as product of recycling biowaste. While in DETDZ case, reused desulphurized flying ash and bottom dust from the local power plant does not only create a new material markets for them but also enhances customer-supplier relationship through by-product connection with the brick and asphalt companies. The same result also shows in NIE case where by-product exchange connection from spent acid and chemical gypsum projects create a new material market and strong relationship between customers and suppliers.

- Energy

In energy area, there is no much improvement made by the three cases reviewed even though they all tried to minimize the use of energy by improving process performance. Due to no big companies which produce its own energy or supply sufficient materials and by-products that can be used to generate energy (most industries in the three cases studied are small-scale industry) the possibility for spin-off energy firms can not be conducted. Nevertheless, NIE and LIK successfully created new alternative energy sources from fermentation biodegradable waste and recycling biowaste. In the future, this new alternative energy will reduce dependency of the companies on fossil fuel.

- Marketing

The interesting part is shown by LIK in improving a marketing area. The availability of Graha Pariwara showroom eases the companies to promote their products. With this facility there is a possibility to conduct joint promotion or joint venture to enlarge a market area. There is also strong desire from the three cases studied to access green market by promoting green labelling. In NIE case, the recycled process activity attracts new companies to involve in this project.

- Transportation

Table IV.2 shows a contradictive result between EIP theory and practices as seen in the importance of transportation improvement. It seems that transportation is not the most feature that the three cases studied want to improve although theory stated there are many rooms for cost saving in this area, for instance by sharing commuting and shipping. This

condition seems to happen because the estates are close to multimodal of transportation. Hence, cooperation in transportation does not see as a crucial factor.

- Human resources

It seems the Comprehensive Environmental Management Systems conducted by DETDZ results significant improvement in human resources area compared to that in the NIE and LIK cases. The significant improvements are shown by recruiting human resources, wellness programs, enhancing security of work place, and coordinative training. Cleaner Production and ISO 14001 promoted by DETDZ show the wellness programs and guaranty security in work place while APELL program recruits more qualified and professional employees. APELL also gives education and training to the stakeholders about hazardous materials management and emergency preparedness. On the other hand, in NIE case, the recycling process in spent acid project has created new jobs for 10 persons. While with Good Housekeeping program, LIK created a safety place at work.

- Environment/health/safety

The CEMS program which is conducted by DETDZ shows significant result in improving environment, health and safety. It is not improving health and safety in the plant area only but also to the community by giving education through multimedia such as airing TV advertisement, publishing newsletters, and signposts about environmental protection. In the NIE case, the improvement conducted through recycling activity projects such as spent acid, chemical gypsum, chemical iron sludge, and biodegradable waste minimizes waste and makes them valuable materials. Beside that, the cooperation by-product exchanges ease them to share environmental information system. While in LIK case, with the 5Rs (Reduce, Reuse, Recover, Replace, Recycle) in Good Housekeeping program will minimize waste production.

- Quality of life/community connection

In this area, the programs proposed by both NIE and LIK do not display any improvement. It seems that the development processes are limited to the companies first and focused to reduce or reuse scrap and production waste. On the other hand, significant improvement is shown by DETDZ case. Since industrial estates in China, including DETDZ, ware designed with dual function, production and residential area, any development in a plant area will also affect the residential area. Hence, any developments and programs should be integrated with a municipal planning. The Comprehensive Environmental Management Systems (CEMS) in DETDZ also involve communities in its programs such as replace coal

with liquefied petroleum gas for domestic cooking in Air Emission Control project. To enhance the awareness of stakeholders as well as communities there is a coordinative education as part of CEMS programs such as water-saving education and training hazardous material management and emergency preparedness.

- Information/communication systems

Cooperative by-product connection in NIE case enforces the members to share valuable information to help each other and make the project successful. There is also a joint discussion to emphasize the potential of network to promote environmental protection solutions. While in LIK case, Graha Pariwara showroom is used as an exchange marketing and product information. In DETDZ case, the management estate used GIS to monitoring the zone's potential hazardous sites.

4.6. Potential Benefits

Even though the development projects are still in process and too early to decide whether they succeed or fail but some potential benefits have been indicated. *Table IV.3* shows that NIE and DETDZ cases almost have similar result while LIK has less result. Nevertheless, it does not mean EIP project in LIK has failed. All projects are still in early phases of development and sufficient data stating the results from each project are not available. Hence, this calculation is not an absolute result since it is based on the current project development from literatures studied and there are still rooms for improvement in the next phase. The benefit calculation itself is based on the three pillars of sustainable development: environment, economic, and society, to figure out if the three pillars receive equal attention.

In environmental sector, DETDZ projects give better result compared to the two counterparts. This is easy to understand since DETDZ project's objective focuses more on the environmental improvement. It was shown by its programs aiming to increase natural ecosystems protection and continuously improving the environment such as air emission control and integrated water management programs. But in reducing waste, NIE project gives a better result. With its approach (utilise synergies of industrial networking toward pollution prevention) companies do not only reduce industrial waste but also make waste as valuable materials by working together with other companies to reuse or recycle them. DETDZ and LIK actually do the same as well but in the plant level only. Their programs (cleaner

production and good housekeeping) have little cooperation with other companies to solve industrial waste. By working individually, some of industrial waste only gain less treatment and quickly deliver to final disposal because the companies do not have sufficient technology to process them.

Table IV.3 Potential benefit earned by the three cases reviewed

Benefit	Theory	NIE	DETDZ	LIK
Environment				
▪ Reduced waste	+++	+++	++	++
▪ Better resource use	+++	++	++	++
▪ Increased protection of natural ecosystems	+++	++	+++	++
▪ Continuous environmental improvement	+++	+	+++	+
Economic/business				
▪ Reduction in disposal cost	+++	+++	++	+
▪ Income from sale of by-products	+++	+++	+	+
▪ Reduction of environmental liability	+++	+++	+	++
▪ Enhance market image	+++	++	+++	++
▪ High performance workplace	+++	+	++	+++
Society/community				
▪ Expanded local business opportunities	+++	+++	+	+
▪ Partnership with businesses	+++	+	+	++
▪ Good job	+++	++	++	++
▪ Improved environmental/health/safety	+++	++	+++	++
▪ Enhanced quality of life in areas near eco-industrial development	+++	++	+++	+

Legend: + indicate well performance; ++ indicate good performance; +++ indicate better performance; and 0 indicate indifferent performance

In economic sector, by-product exchange cooperation has successfully increased profits for the companies in NIE case. The four recycling projects (recycling of spent acid, chemical gypsum, chemical iron sludge, and biodegradable waste) do not only reducing the companies' disposal costs but also raise additional income by selling them to the new market. With by-product exchange coordination, they also reduce liability of resources from the environment. In DETDZ case, the estate successfully enhances market image and access for a green market. With a good image and better infrastructure and facilities, it will give DETDZ more opportunity to attract new investors. Meanwhile, in LIK case, with its good housekeeping program, there will be much cost saving that can be made to create a conducive workplace in order to enhance good performance of employees.

In society/community sector, DETDZ project successfully improved environmental quality, health and safety of the zone, particularly with the application of APELL program. This program does not only preventing technological incident and reducing the impact if the incident occur but also educates and trains the stakeholders about hazardous materials management and emergency preparedness. The other DETDZ projects such as air emission

control, forest management and biodiversity conservation have enhanced quality of life in an area near the eco-industrial development by creating fresh air, clean water and green neighbourhood. On the other hand, NIE project with its by-product networking has successfully expanded a local business opportunity. The expanded local business opportunity means providing new jobs for local people. In creating partnership with business, even though not as much as the theory wants but LIK project shows a better result compared to the two counterparts. The existence of scavengers who separate and collect commercial value waste from non-commercial value waste such as papers, plastics and glass, and then sell them to recycle factories or waste collector from the city has created good partnership with business.

Chapter V
Conclusions and Recommendations

5.1. Concluding Remarks: Lessons Learned

The three cases studied shows that by implementing the eco-industrial park principles many benefits and opportunities will be gained by the companies. For instance, LIK with its good housekeeping program has created health and safe work place and continuously enhance production processes which in the end can make many costs saving. While NIE with its by-product exchange networking successfully creates additional income by reusing and recycling waste with other companies and successfully solve industrial waste which might be difficult if they do individually. On the other hand, DETDZ with its comprehensive environmental management system approach has successfully increased the estate image as well as public and open an opportunity to extend its market through its green labelling.

Nevertheless, the three cases studied have not resembled an eco-industrial park yet as the theory expected. Each case studied gave more portions to one sector and less to the other. For instance, NIE project paid more attention to reuse or recycle waste in order to reduce waste discard to landfill and get benefit by selling them while public does not get benefit from its project. On the other hand, DETDZ project focused more to create clean environment by implementing many regulations. Nevertheless, this condition makes the companies difficult to obey them if there is no benefit or additional income from this activity. Meanwhile, LIK project only focused on how to increase the performance of the production processes and individual environmental aspects with little effort to make networking with other companies to solve industrial waste and to improve quality of life in a surrounding area.

From the above explanation, it will be better for each estate if they learn from their counterpart programs. For example, NIE, whose area is bigger than DETDZ, adopts comprehensive environmental management system and APELL program to increase public awareness and participation, and increase prevention for technological incidents and reduce the impact if it occurs. On the other hand, it will be better if LIK's project do not only focus to

improve its individual production processes but also adopt by-product networking such as conducting by NIE to create additional income.

5.2. Recommendations

From the three cases studied, there are some important factors that one should consider when developing an EIP. *First*, one should assure active participation of all stakeholders in planning and implementing stages of project. Nevertheless, active participation of the companies is an important factor in here since they are the actors who will implement the project. The participation of educational institutions and practitioners in conducting research and analysis to find technical solution and alternative for by-product exchange networking is also important to attract participation of the companies.

Second, the selection of an approach and program must give equal result to increase additional income and environment protection. It should be remembered that most of industries in the three cases studied, and in developing countries in general, are small-scale industries and weak in financial capital. If the project only focuses on environmental protection with less attention to create additional income, then the companies will face difficulty to implement the project. The initiator along with companies' members and government should sit together and discuss the best approach or program that can give win-win solution both for economic development and for environmental protection based on the characteristics of the companies and current situation of the estate.

Third, the cost of EIP planning and implementing should be shared between the companies, developer or management, and government. In DETDZ case where the government gave a full financial support for the success of the project, it then only created passive participation of the companies. The government should give more autonomy to the

companies to increase participation. By sharing the cost, companies' commitment will be more enhanced to realize the successful of project (Herees et al. 2004).

Fourth, transparency and supply information are the other factors that one should consider. The LIK case shows us an important lesson how the companies are reluctant to participate in the project because of lack of supply of information about the project. They doubt if they release their information relating to production processes and waste generation to the initiator project, other companies will copy their processes or will be prosecuted by the government for wrongdoing (UNEP 2001.c). Thus, before the project begins, the initiator should inform the goal and objectives of the project clearly to the members and make the whole process transparent to build trust between them.

Finally, strict implementation of regulations and continuous reducing subsidies of energy- and water-uses will encourage the companies to enhance their production processes and voluntarily implement EIP concept. A good example is shown by DETDZ case where the government implements water quota pricing system to enforce the companies to minimise and reuse their water. With this system, not only the numbers of wastewater generation will continuously decrease but also costs saving for the companies by reducing cost for water uses and tipping fees for wastewater discharged will increase.

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