

The Integration of Occupational Health and Safety into the Development of Eco - Industrial Parks

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ABSTRACT: Large industrial estate has a significant impact on communities and people's health. Eco-Industrial Park (EIP) is one of the strategies to implement the concept of industrial ecology by inter-company collaboration. The whole concept is that EIP development combines business success, environmental excellence, and community relationships to create economic opportunities and promote environmental sustainability. Various basic eco-criteria are fundamental to the development of an EIP such as energy efficiency, waste management, land use, and material / chemical flow, etc. Eco-industrial development is not limited to these types of activities which focus on a group of companies implementing environmental technologies. In addition, EIP considers a combination of the other criteria used such as cultural, social, health and safety for its development. Ordinarily, occupational health and safety (OHS) has not achieved a high profile in the sustainable development. Many studies have identified the place of OHS on sustainable development as a small part in an attempt to make arguments regarding OHS in a definite specific agenda. This paper aims to review the status of OHS and its role in the development of EIPs.

Keywords: Eco-Industrial Park (EIP), Occupational Health and Safety (OHS), Sustainability, Industrial ecology

Introduction

While industrialization brings wealth and development to country's economies, it has also carried along many problems, and one of these is industrial pollution. The current global environmental problems have been created by the development of industrial society. The pollution caused by factories involves not only airborne emissions, but land and water pollution as well. Moreover, the large Industrial Estate has significant impact on communities and people's health. It has undergone significant changes and developments with reflections on issues of workplace health and focuses on significant health care needs. The problem emerging from these considerations is the continuous restructuring and reorientation of occupational health services, to meet challenges created by the changing nature of working life and environment (Arve Lie *et al.*, 2002). Applied EIP aims at reducing a broad range of environmental impacts, including not only the mass of wastes and gas emissions, but also impacts on human health and ecosystems (Thomas *et al.*, 2003). To integrate Eco-industrial across diverse dimensions of environmental performance, a number of Eco-criteria have been developed. The approaches applied to develop EIPs are very diverse as such cultural, institutional, political framework are influencing the execution originated in different countries or regions (Boons and Howard-Grenville, 2009). The purpose of this paper is to review the status of OHS and its role in the development of EIPs through a systematic literature review.

Aims of this report

The aim of this report is to serve as an initial review research for the integration of OHS into EIP project and other possible future development projects. This report gives an overview of the concept of EIPs: 1) the field of strategies and Eco-criteria are discussed and the concept of OHS within EIPs is described and 2) a specification criteria and indicators which related to OHS in Thailand and abroad are reviewed.

This report gives an overview of the scientific concept of EIPs for the benefit of OHS of the EIP project. Experiences gleaned from previous cases should facilitate the planning and implementation of the EIP. The key challenge is to accommodate and apply the concept of OHS in EIPs and international experience into the specific features of the individual network.

Eco-Industrial Park

Regularly, EIP’s was known as the environmental performance, which better than simple compliance to regulations. This alone makes support for the innovations they request a priority in regulatory agencies (Lowe and Evans, 2001). According to Indigo Development Institute (2005), the public and private sectors began more than one hundred EIP projects in Asia, Europe, Africa, North America, Latin America and Australia. Since each country is at a different stage of environmental policy and regulatory development, the goals of policy makers in environment and industrial development will be very well supported by meeting the needs of industrial park developers and managers who wish to create EIPs.

An EIP may also be planned, designed, and built in the direction that makes it easier for businesses to work together, and those results in a more financially sound, environmentally friendly project for the developer. In **Table 1**, other strategies are components of the broader field of industrial ecology that might be adopted by EIP tenants, but do not necessarily contribute to the inter-firm cooperation of industrial parks. Strategies such as resource recovery or deconstruction and remanufacturing could be adopted either by individual tenants or serve as a theme for an EIP as a whole.

Table 1: Eco-Industrial Development Strategies.

Country/ References	Strategies
Australia Roberts, B. H. (2004). <i>The application of industrial ecology principles and planning guidelines for the development of EIPs: an Australian case study</i> . Journal of Cleaner Production, 12(8), 997-1010.	<ul style="list-style-type: none"> • A holistic systems approach to resource management, balancing environmental performance with economic and industrial viability. • Use of an interdisciplinary approach to research, planning and implementation, linking fields such as ecology, economics, engineering, business, public administration and law. • Examination of material and energy flows through complex industrial systems. • Reduction of energy / material flows used for production and impact of consumption on the environmental sustainability. • The re-design of manufacturing system to include activities which reduce ecological footprints.
Globe Côté, R., & Hall, J. (1995). <i>Industrial parks as ecosystems</i> . Journal of Cleaner	<ul style="list-style-type: none"> • Site Selection and Design: Prepare a site development plan. And the relevant regulations and guidelines are available. • Building Design and Construction: Develop a landscaping plan to minimize wasteful use of land, heat and water as well as for architectural building requirements.

Country/ References	Strategies
Production, 3(1), 41-46. Côté, R. P., & Cohen-Rosenthal, E. (1998). <i>Designing EIPs: a synthesis of some experiences</i> . Journal of Cleaner Production, 6(3), 181-188.	<ul style="list-style-type: none"> • Substitution/Use of Environmental Products: Review of materials and wastes to substitute chemicals whose quantity, toxicity, persistence and degradation raise serious concern. • Material Cycling/Exchanges: A system to allow the cycling, exchange or transfer of materials within the park. • Feedback and Communications: There is a need for feedback mechanisms to regulate the flow of materials and the growth of populations and communities.
Thailand Industrial Estate Authority of Thailand. (2012). <i>Specification criteria and indicators to promote into the Eco Industry</i> .	<ul style="list-style-type: none"> • Physical: location, space layout, building and surrounding area design • Economical: The economy of locality, The economics of the industry, The economy of local community, Marketing, and Transportation and logistics • Societal: Quality of life and society of the surrounding community, and Quality of life and social life of workers • Environmental: Water management, Air pollution management, Waste and waste materials management, Energy management, Sound management, Production process, Eco-efficiency, Health and safety, and Environmental monitoring • Managerial: The management of the involved area, Improvement and maintenance of management system, Improvement of personal quality, and Information and reporting

Based on the range of classification of EIP initiatives in literature (e.g. Schlarb, 2001; Roberts, 2004; Indigo Development, 2006 and others), it is clear that the explanation of EIP has not been well developed to scope the boundaries in order to identify what kind of initiatives can constitute an EIP (Trillium Planning and Development INC., 2003). New EIPs can be constructed around already existing operations or created from scratch. Cooperation that develops over a period of time is needed to implement and keep EIPs running. Therefore an evolutionary approach should be adopted (Saikkuu, 2006). Recently, Massard (2012) has summarised a set of Eco-criteria which undertaken at the meso scale to foster a transition to a long-term viability of industrial system (**Table 2**). The most exemplifying eco-innovation parks consider a combination of several of the below-mentioned criteria.

Table 2: List of Eco-criteria (Massard, 2012)

Eco-criteria	Details
Energy efficiency	Optimization or reduction of energy use, including energy needed for buildings and other infrastructure as well as production
Renewable energy sources	Use of and/or on-site production of renewable energy includes solar, wind, hydropower, combined heat and power generation by waste, geothermal energy, tidal/wave generated energy, biofuels
Waste management	On-site collection, transport, on-site/external processing (recycling) or disposal of waste
Water management	On-site wastewater treatment, reduction/optimization of water use for infrastructure and production
Material / chemical flow	Synergies, materials exchange among companies, collaborations, Input-output scheme defined by industrial symbiosis
Biodiversity	Biodiversity conservation or natural revitalization in the industrial/urban and surrounding area
Mobility, transportation	Efficient viable transport of goods or people with low environmental impact (e.g. electric vehicles, plug-in hybrids)
Land use	Optimization/reduction of land use for industrial/urban infrastructure, revitalization of derelict land (industrial/urban zone)
Air pollution prevention	Reduction in pollutant emissions through cleaner production processes or end-of-pipe technologies
Noise prevention	Reduction in noise emissions through cleaner production processes or end-of-pipe technologies
Environmental management	Certification and labels with environmental standards at the park scale such as ISO 14000
Cultural, social, health, safety	Cultural aspects, social aspects: gender equity, professional reinsertion, child care. For health: safe and clean natural and working environment in the industrial/urban and surrounding area

The majority of EIPs do not seem to plan the development of exchanges or partnerships. Existing examples of industrial ecosystems reflect the difficulty to organize and maintain initiatives that are based upon the exchange of energy and materials (Adamides and Mouzakitis, 2009). The eco-criteria with the highest occurrence consist of waste management, energy efficiency and material flow, respectively. These criteria are usually considered as common strategies for industrial park management in many countries. Their innovative component in case studies is sometimes unclear. Therefore, the high occurrence does not mean that the resource management can be in any case characterized as

innovative. Supportive policies are imperative to EIP development. Many national policies still emphasize end-of-pipe emissions measurement rather than an industrial ecology systems approach with a focus on integrated planning (Chiu, 2001). Conversely, eco-criterion like health and safety is probably underrepresented due to the tendency to apply solutions at the micro scale (company) rather than at the meso scale (park) and to their under indicating in the industrial ecology literature (Massard, 2012).

Occupational health and safety (OHS)

OHS is a cross-disciplinary area concerned with protecting the safety, health and security of people engaged in work or employment. The goal of all OHS programs is to support a safe work environment. Integration of OHS objects into environmental management systems can avoid duplicate measures and find optimal solutions, because the regulations of prevention are identical in environmental protection and safety management. Nevertheless, the methods currently used in environmental management and engineering such as life cycle assessments, technology reports, and the models of industrial production can interrupt this integration. People can also regard occupational safety risks more easily than environmental risks as a natural part of their work (Honkasalo, 2000). By integrating environmental and safety matters the company can get advanced collaboration, especially in noise control, chemical safety, waste management and industrial accident prevention, occupational and environmental factors which are intimately connected to each other. Consequently, the workers need to have the knowledge of the risks and hazards in their workplace, which also affect the surrounding and their living areas.

Health issue in sustainable development

In terms of sustainable development, a framework is needed in which the various environmental, economic and social factors and components can be considered in a balanced way (Schirnding, 2002; Hughey *et al.*, 2004; Amponsah-Tawiah, 2013). While Schirnding (2002) cited a framework for presenting the linkages among factors that affect health in the context of environment and development. It has been adapted from the “pressure-state-response” (P-S-R) model (**Figure 1**) developed by the Organization for Economic Cooperation and Development (OECD). Amponsah-Tawiah (2013) also mentioned on the

triple bottom line (people, profits and planets) and how they are affected by OHS policies and the effects of work related hazards on sustainable development. The paper also revealed that OHS has three pillars similar to sustainability.

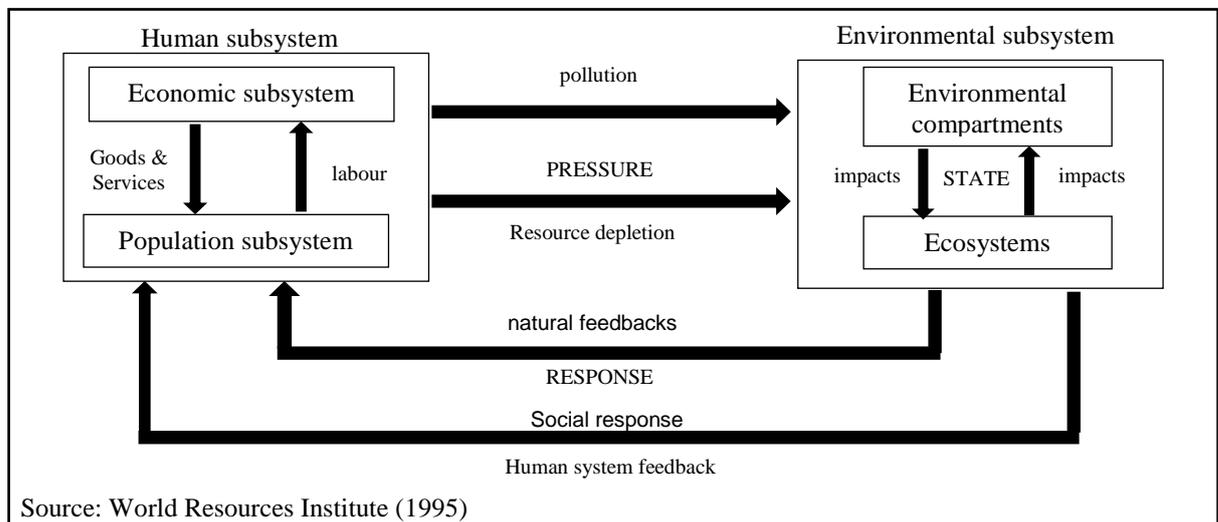


Figure 1: Pressure – State - Response (P-S-R) (Schirnding, 2002)

The P-S-R framework is especially used worldwide as a reporting tool to describe human activities in which pollution affects the environment, by pointing at the different pressures on the environment, changing the quality and quantity (the state) of natural resources. Human management responses to the changes include any form of organised behaviour that seeks to reduce, prevent or ameliorate undesirable changes (Schirnding, 2002; Hughey *et al.*, 2004). The OECD uses the P-S-R framework to provide the basis for a classification of indicators using a number of environmental issues which reflect major environmental concerns in OECD countries (Hughey *et al.*, 2004). In the causal chain, social and economic developments are considered driving forces that exert pressure on the environment, leading to changes in the state of the environment. In turn, these changes lead to impacts on human health, ecological systems and materials that may elicit a societal response that feeds back on the driving forces, pressures, or on the state or impacts directly (Smeets *et al.*, 1999).

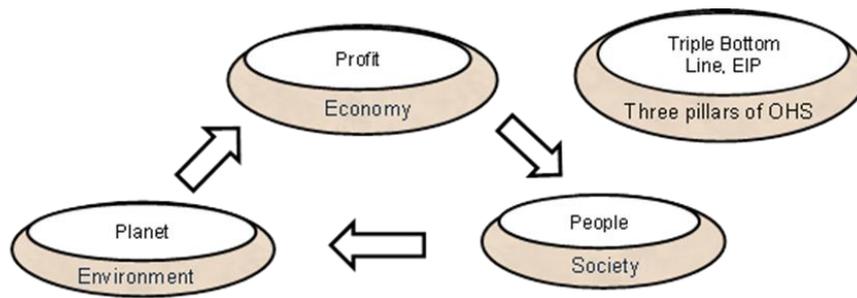


Figure 2: OHS sustainable development interface (Amponsah-Tawiah, 2013)

Following the Amponsah-Tawiah’s report in 2013, it reviews literature on the triple bottom line (TBL) and how they are affected by OHS policies and the effects of work related hazards on sustainable development. The TBL comprises of the three Ps: profit, people and planet. It refers to the financial, social and environmental performance of the corporation over a period of time. A sustainable labor force is prudently connected to business quest to optimize profitability. Various descriptors such as compensation claims, employee turnover, and accident record arising out of disregard for OHS issues have severe impacts on productivity and shareholder asset maximization. Planet confines the environment and it facilitates trades to be eco-efficient. The environment stays largely the most extraordinary arena that sustainable development literature appears to have been written on actively for the past two decades. The environment is exquisitely coordinated with every single human attempt and that the sustainability of the human species has so much to do with the environment. Finally, the role of firms to “people” was concluded by Willard (2002) that employees need to be able to rely on a safe work environment that continuously reduces risk of injury and health and safety protection. This is the basis for maintaining a sustainable workforce.

Occupational health and safety role in Eco-Industrial Park

Occupational health and Safety is a basic element and constitutes a social and health dimension of the principle of sustainable development. OHS practices constitute a set of key activities for such development. Unfortunately, a few studies have been drawn to the role of OHS to sustainable development (Kakabadse *et al.*, 2003; Adei and Kunfaa, 2007; Kurup and Stehlik, 2009; Amponsah-Tawiah, 2013). Studies exploring the role of OHS on sustainable development are either fragmented or their relationships only glossed over in an endeavour to make arguments regarding OHS in a certain particular agenda (Amponsah-Tawiah, 2013). In

Ontario, eco-industrial networking projects in Sarnia are more about business retention than attracting new investment because construction costs and other factors have influenced investment decisions. A number of projects have generated significant returns on investment as well as improved the level of environmental quality, health and safety (Canadian Eco-Industrial Network).

Discussion

Although most of the EIPs recognize the process of environmental management as the main element of the EIP, the proposed indicator as Health and Safety has not been widely applied over time. Nevertheless, satisfactory working conditions provide various benefits, and the beneficiaries are both direct and indirect. The direct beneficiaries are the workers themselves, since they are the most affected by accidents, but also the firm, because it avoids losses and improves its profitability. The indirect beneficiaries are the insurers, contractors, consumers, families and society in general. In the EIP, Health and Safety has played its important role in term of benefits, basic needed and used as a criterion.

Conclusion

Table 3 is a summary of OHS role in EIPs. Regarding these results, we can summarize that this report identified an important theoretical gap: the possible indicator that regard a proficient view of the problem. Basically, data of OHS is an important element and readily data from the company. Safety performance can reduce the accident rate, hence the personal injuries and material damage, and simultaneously improves working conditions which raise employees' motivation and reduce their absenteeism. Hence, Health and Safety indicator can be seen as an opportunity to promote environmental sustainability in the EIP development.

Table 3: Result of Systematic Literature Review

Role / References	Descriptors
<p style="text-align: center;">Benefits</p> <p>Canadian Eco-Industrial Networking <i>Benefits of Eco-Industrial Networking</i>.</p>	<p>The recent growth of eco-industrial networks in Canada stems from the wide range of economic, environmental and social benefits gained by businesses and communities alike. In Ontario, a number of projects have generated significant returns on investment as well as improved the level of environmental quality, health and safety.</p>
Role / References	Descriptors
<p style="text-align: center;">Benefits</p> <p>CHIU, S. & TSENG, M. 2004. Production management toward sustainable development. Proceedings of the Fifth Asia Pacific Industrial Engineering and Management Systems.</p>	<p>The consideration of products with regard to their features is being done primarily as a result of customer demands. The international concept of "Extended Producer Responsibility" is quickly establishing itself as a modern consideration in identifying, organizing and minimizing safety, health and environment risks on a product's entire life cycle, from the procurement of raw materials to production, use and disposal.</p>
<p style="text-align: center;">Criterion</p> <p>OH, D.-S., KIM, K.-B. & JEONG, S.-Y. 2005. <i>Eco-industrial park design: a DaedeokTechnovalley case study</i>. Habitat International, 29, 269-284.</p>	<p>Daedok TechnoValley (DTV) Development Project is the first Korean attempt to design EIP by restructuring a conventional industrial estate development plan. By concern with public health, safety and environmental protection, industry have been at the center of the debate on sustainable development. Nonetheless, higher levels of progress towards sustainability in the aspects of 'external green space design' and 'energy efficient, healthy building design' could be achieved within the site.</p>
<p>INDUSTRIAL ESTATE AUTHORITY OF THAILAND 2012. <i>Specification criteria and indicators to promote into the Eco Industry</i>.</p>	<p>Industrial Estate Authority of Thailand (IEAT) has set up the specifications, standard for factories and Industrial Estates that plan to develop in the Eco - industry city and they have to follow these Eco-criteria in 5 dimensions and 22 aspects. In this regard, "Health and safety" was set up as one of the aspect in the environmental category.</p>

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