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Eco Industrial Development: As a Way of Enhancing Sustainable Development

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Abstract. *The world's habitat is being deteriorated especially due to the unsustainable production. The need for sustainable development and reducing humanities' environmental footprint have been addressed in various international frameworks, meetings and reports (e.g. Kyoto protocol, the Resource Efficiency and Cleaner Production Program, the Ten Year Framework of Programs on Sustainable Consumption and Production, the UN Resource Panel, and the Green Economy Initiative, Rio+20, green building certificates, "UNEP Green Economy" in 2011, "Green New Deal" in 2012, the Intergovernmental Panel on Climate Change's report etc.). EIDs (the eco industrial development) can act as catalysts in sustainable development and in reducing environmental footprint of the production processes. Based on an in-depth literature review, this paper aims to analyze how EID can be supported so that environmental footprint of the production processes can be reduced contributing to sustainable development. With this aim, the objectives include: analysis of the need for the EID; need for the sustainable development enhanced by sustainable production and sustainable products; key success factors for, barriers against and drivers for the EID. The policymakers, companies, and researchers are expected to get benefit from this paper.*

Keywords: eco industrial development, eco industrial parks, sustainable production.

JEL Codes: *O1, Q5, Z00*

1. Introduction

The world's habitat is being deteriorated (i.e. water depletion, loss of biodiversity) (Tukker, 2013: 274). The growing industrialization and increase in the scale of economic activity have transformed the world's resources into wealth causing adverse effects on ecosystems and resources (Linnenluecke and Griffiths, 2013: 382). Nature is under the combined pressure of human population growth and the growth in the wealth per capita (Tukker and Butter, 2007: 102). The 'economy is crashing against the Earth' (Tukker, 2013: 274). The world economy is expected to grow by 3% per year until 2030 and more than 9 billion

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humans are expected to live on earth by 2050 (Rohn et al., 2014: 32). The economic growth puts pressure on the environment (Tukker and Butter (2007: 102).

The economic growth's adverse effect on the environment is expected to be increased due to the need for a US$200 trillion global economy by 2050 to eradicate the poverty, while not affecting the income of the rich, as well as fulfilling the aspirations and expectations of the middle class (Tukker, 2013: 272). The economy needs to be sustainable. An economy is sustainable only if it simultaneously caters human needs – in particular the essential needs of the world's poor – and accepts the limitations imposed by the need to sustain the environment's ability to meet present and future needs (Lorek and Spangenberg, 2014: 33).

Despite of rising prices for natural resources during the past 30 years, there is increase in the global consumption of natural resources (Rohn et al., 2014: 32). The Earth, however, has its limitations (Ayres and Kneese, 1969; Daly, 1991; Meadows et al., 1972; Tukker, 2013: 272). As stated by The Club of Rome's (1972) Limits to Growth, economic growth cannot continue indefinitely due to the limits of the capacity of the global environment (Jung et al., 2013). Essential needs are not substitutable and as limits are clearly referring to the environment, and not to natural capital or a substitute thereof (Lorek and Spangenberg, 2014: 33). As the environmental degradation continues to occur in an accelerated way, time is of the essence for taking effective precautions. The report from the Intergovernmental Panel on Climate Change (IPCC) called for immediate action (EC website, 2014). The fact that the world's habitat is being deteriorated (i.e. climate is changing, the earth's temperature is rising, and the earth resources are being exploited) despite of the precautions (e.g. Kyoto protocol, the Resource Efficiency and Cleaner Production (RECP) Program, the Ten Year Framework of Programs on Sustainable Consumption and Production (10-YFP on SCP), the UN Resource Panel, and the Green Economy Initiative (GEI), Rio+20, green building certificates, "UNEP Green Economy" in 2011, "Green New Deal" in 2012 etc.) taken reveals the need for acting strategically (e.g. encouraging ecoindustrial development, enabling sustainability transition, degrowth, dematerialization, and encouraging the change agents for sustainability) for the survival of humanity considering technical, and socio-economical aspects and reducing the footprint of the humanity (including, production processes).

CE (Circular economy) and IE (Industrial ecology) enhanced by the EID (eco industrial development) need to be encouraged for reducing humanities' environmental footprint. CE is based on (Stahel and Reday, 1982): perception of waste as food or input; perception of diversity as strength; relying on renewable energy sources; and systems thinking. The CE encompasses principles mainly from: closed loop system; biomimicry; IE; and cradle-to-cradle. IE can be defined as a community of manufacturing and service business collaborating for economic and environmental benefit by managing energy, water, materials and other resources (Love et al., 1996). (Zhu and Cote, 2004: 1025). IE is based on a complex and self-organized closed-loop system similar to that in nature (Panyathanakun et al., 2013: 71) and transforms the industrial system and minimizes inefficiencies by learning and mimicking from the natural environment and how natural environment works (Chertow, 2000; Graedel and Allenby, 2003; Korhonen, 2007; Lambert and Boons, 2002; Pakarinen et al. 2010; Romerao and Ruiz, 2014). IE can contribute to the sustainable growth (Panyathanakun et al., 2013: 71).

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IE is supported by the EID (eco industrial development) which is a framework for the development of the industry reducing its adverse effects to the environment (Cohen-Rosenthal, 2003). EID is based on the biological symbiosis and on the closed loop production cycle principles (Lown, 2003). Mutually beneficial connections among industry, natural systems, energy, material and local communities are considered as central factors in designing industrial production processes (Cohen-Rosenthal, 1999). EID aims to improve business and environmental performances mainly through: resource efficiency (Babu and Meyer, 2012); cleaner product; IE; industrial symbiosis; environmental management systems; and design for the environment.

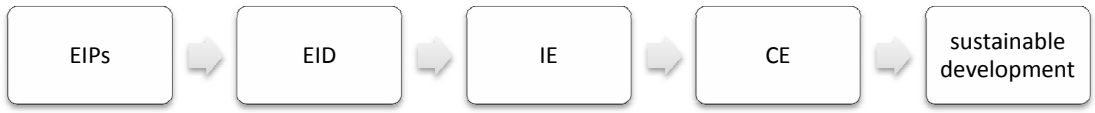

Fig. 1: The relationship among EIPs, EID, IE, and CE

An important application of the IE concept is EIP (the Eco-Industrial Park) (Panyathanakun et al., 2013: 71). EIP can be defined as "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" (Veiga and Magrini, 2009: 653). EIPs lead to the EID which supports IE and IE leads to CE enhancing the sustainable development (Figure 1). EIPs are based upon IE principles which suggest that industrial systems can operate like natural ecological systems (Jung et al., 2013: 50). EIP is based on the idea of the industrial symbiosis which aims to engage separated industries in a collective approach so that their economic performance is improved whereas their environmental footprints are reduced (Chertow, 2000; Fang et al., 2007; Oh et al., 2005: 271; Tibbs, 1992; Yu et al., 2014). EIPs enable engagement of separated industries through "significant, systematic industrial change" including physical exchange of materials and by-products, shared management of common utilities and infrastructures (Chertow, 2000; Fang et al., 2007; Tibbs, 1992; van Berkel, 2009; Yu et al., 2014). EIPs connect different waste-producing processes, plants, and consumers (Fang, 2003; Fang et al., 2007: 319). Panyathanakun et al. (2013: 71) emphasized that the EIPs enable not only tangible exchanges [i.e. the physical exchange of materials, energy, water, and by-product (Chertow, 2007)] but also intangible exchanges of knowledge and human or technical resources (Mirata and Emtairah, 2005). The exchanges of resources and collaboration among collaborative companies in the production process lead the emergence of synergy (Cote and Cohen-Rosenthal, 1998; Lowe, 1997; Panyathanakun et al., 2013: 71; Romerao and Ruiz, 2014: 394). "The collaborative community of companies in EIPs establish the 'industrial ecosystem'. (Lowe et al., 1996; Lowe, 2001; Veiga and Magrini, 2009: 653)" (Oh et al., 2005: 271)

EIPs can be established for new developments as well as for redevelopments of existing or obsolete industrial sites (Pellenbarg, 2002). Majority of the EIPs have been developed as a result of transformation of existing industrial parks (Mathews and Tan, 2011; Yu et al., 2014). As the enterprises in traditional industrial parks aimed at high economic output without considering the 'costs' of environmental degradation,

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transformation of existing industrial parks into EIPs is expected to contribute to the solution of the environmental pollution problems and to the sustainable development path (Bai et al., 2014: 5). For this reason, EIPs are perceived as a new industrial model to address the three dimensions of sustainability, namely: social, economic and environmental (Veiga and Magrini, 2009: 653). EIPs have been established throughout the world [i.e. Europe (Baas and Boons, 2004; Tudor et al., 2007), China (Fang et al., 2007; Zhang et al., 2010), India (Singhal and Kapur, 2002), the Americas (Gibbs and Deutz, 2005, 2007), Australia (Roberts, 2004), and Japan (Berkel et al., 2009)] (Jung et al., 2013: 50).

CE, IE and EID support the sustainable society which relies on sustainable consumption, as well as on sustainable production (Lorek and Spangenberg, 2014). For this reason, change agents are needed to foster the EID. According to Wangel (2011: 873), the term 'agency' refers to 'the social' part of the socio-technical society, which consists of formal institutions (i.e. policies, taxes, and organisations), and informal institutions (i.e. norms, values, and social practices). Individuals and organisations having the capacity to act can act as agents (Wangel, 2011: 873). Sustainability leaders are the change agents who play the key role for the successful transformation towards sustainability, as well as for regional EID.

Changing unsustainable production has been identified as one of the objectives of sustainable development in the 2002 World Summit on Sustainable Development (UN, 2002; Barber, 2007: 499). There is need to foster EID as a tool to reduce environmental footprint of the production processes so that sustainable development can be achieved. For this reason, based on an in-depth literature review, this paper aims to analyze how EID can be supported so that environmental footprint of the production processes can be reduced contributing to sustainable development. With this aim, the objectives include: analysis of the need for the EID; need for the sustainable development enhanced by sustainable production and sustainable products; key success factors for, barriers against and drivers for the EID.

2. Sustainable Production and Companies as Change Agents for Sustainability

Companies acting as change agents for sustainability need to be active in the sustainable production so that they can support EID. Companies can be major contributors to sustainable development as they are perceived as major contributors to ecological problems (Clifton and Amran, 2011; Roy and Goll, 2014: 851-852). Stakeholders' and consumers' growing pressures encourage companies in engaging in sustainability and in sustainable development, as well as in aligning the corporate values with those of the society (Matos and Silvestre, 2013; Musson, 2012; Seuring and Müller, 2008; Steurer, Langer, Konrad, and Martinuzzi, 2005). Corporate leaders and employees are increasingly recognising their role in contributing to sustainability (Lozano, 2012: 14). Companies in the supply chain, as consumers of resources throughout the production process play vital role as change agents for sustainable development. Their role can be supported by the EIPs which enable emergence of synergy especially with respect to tangible and intangible resources exchanges. As companies need to achieve economic success and their survival while enabling ecological protection (Clifton and Amran, 2011; Stead and Stead, 2000), they can be supported by the synergy of the EIPs.

Eco-labelling: Eco-labels support the EIPs aims as they encourage sustainable production which can be enhanced by increased synergy among the companies in the EIPs so that they can reduce their environmental footprints. Eco-labels provide the consumers information about the environmental impacts

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of products (Reczkova et al., 2013: 498). For this reason, they have the potential for influencing consumers' purchasing decision towards environmentally friendly products (Reczkova et al., 2013: 498). They influence the individual consumers' demand for the end product, as well as the demand of the companies in the supply chain for sustainable/environmental friendly input materials or byproducts. Eco-labelling can act as a marketing tool. Advantages of certification and eco-labelling include (Chkanikova and Lehner, 2014):

- influencing consumers' demand for environmentally friendly and ethical products (Rex and Baumann, 2007; Elham and Nabsiah, 2011; Larceneux, Benoit-Moreau et al., 2011);
- encouraging sustainability improvements and their implementations 'upstream' in the supply chain (Burch and Lawrence, 2005; Deaton, 2004; Hatanaka, Bain et al., 2005; Henson and Humphrey, 2010; Seuring, 2011; Wu et al., 2010);
- allowing companies in the supply chain (e.g. retailers) to establish collaborative relationships with suppliers to improve product sustainability performance (Wu et al., 2010; Kogg and Mont, 2012);
- enabling the reduction of the transaction costs in appointing/assigning suppliers satisfying the sustainability criteria set for product's sustainability performance (Beckman et al., 2002; Vorley et al., 2002; Wathne and Heide, 2004);
- enabling the companies to purse differentiation strategy and to generate higher profit margins lowering production costs (European Commission, 2011a,b,c; Jung and Sung, 2008; Kotler, 2002; Orsato, 2009);
- encouraging the market for sustainable products (Chkanikova and Lehner, 2014);
- encouraging the companies to proactively address sustainability issues both upstream and downstream in the supply chain (Chkanikova and Lehner, 2014).

Policies and Government: Leadership is crucially important for the establishment and implementation of the effective policies needed for the EID. Governments are increasingly being held responsible for their sustainability performance (Roy and Goll, 2014: 849). Local governments should invest in a sustainable development policy to satisfy citizens and benefit companies and act with companies as partners to increase resilience and sustainability (Musson, 2012: 75). Policies play the key role in improving local and global sustainability (Editorial Journal of Cleaner Production, 2005: 967-969), as well as EID and EIPs. The recently carried out international meetings and programs (i.e. Rio+20, the Resource Efficiency and Cleaner Production Program, the Ten Year Framework of Programs on Sustainable Consumption and Production, the UN Resource Panel, and the Green Economy Initiative programs) emphasize the need for sustainability and sustainable production. Policymakers play key role in sustainable development as they can influence the sustainability transition. The policymakers need to act as sustainability leaders and avoid taking populist decisions which might harm the sustainability (Church and Lorek, 2007; Fuchs 2005; Lorek and Spangenberg, 2014: 40-41; Maniates, 2010a, b). The politicians need to enhance the citizens' interest in protecting the environment. As quoted from Jain et al. 2013: 20, there is need for "… 'rational-citizens' so that 'sensible' future for the upcoming generations can be achieved (Ravio, 2011; UNESCO, 1978)". Policymakers should encourage individuals to engage in a wide range of pro-environmental practices (Barr et al., 2011: 1224) as human capital accumulation magnifies the positive growth effects of policies that lower the rate of resource destruction, preserving the welfare of newborn agents (Valente, 2011: 995).

Policies can support establishment of EIPs and transformation of the existing industrial parks into EIPs (Boons et al., 2011; Lehtoranta et al., 2011; Mathews and Tan, 2011) especially through laws and

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regulations (Yu et al., 2014: 466). Hard policies (i.e. regulatory and economic instruments) can influence consumption patterns (Rehfeld et al., 2007; ASCEE team 2008; Lorek et al., 2008). Policies and guidance can create synergy encouraging infrastructure sharing and company interaction (Gibbs et al., 2002; Mirata, 2004; Yu et al., 2014: 466).

Policies can support innovation which enhances sustainability performance of the production process, as well as of the product as "…technological improvements**...** must be combined with and integrated into structural change and sufficiency policy initiatives..." (Lorek and Spangenberg, 2014: 36).

Policies encouraging or requiring environmental friendly production and products can act as facilitators for consumers (companies in the supply chain) to prefer to work in the EIPs. Policies can encourage the consumers' (both individual consumers of the end product, as well as the companies in the supply chain) demand for products and production process having high sustainability performance. For example, the approaches which can support the sustainable consumption include (Akenji, 2014: 19-21): "taking out the unsustainable options from the market or making them less desirable (Maniates et al., 2010); integrating measures of well-being in the accounting for development (Harrison et al., 2005; Hobson, 2006); encouraging grassroots innovation and building communities; as well as defining limits of resource extraction and pollution".

Drivers for companies to act as change agents for EID

Drivers for companies to act as change agents for EID include: improvement of the sustainability performance; economic advantages and competitive advantage; regional development and future employability; policies and regulations.

Improvement of the sustainability performance: The requirements for improvement in the sustainability performance of the production process and of the products encourage the companies to work in the EIPs. Adverse effects of economic and environmental crisis encourage the politics to support CE, EID and transformation of industrial areas towards greater sustainability (Romero and Ruiz, 2014: 394). Sustainability and effective environmental protection have become a vital issue for the long-term development of industries, especially due to the limits of the availability in non-renewable resources, as well as due to limits of the biosphere's ability to absorb wastes (Cao et al., 2009: 2868–2876). EID can lead to the dematerialization of the production process; reduction in the environmental footprints of the production; as well as support of the regeneration of the world slowing down the deterioration rate through reduced resource consumptions and reduced environmental footprints of the production. EID can support the sustainability performance of the companies acting as consumers in the production process throughout the supply chain especially in the way they cope with barriers which can be encountered while adapting the sustainability principles. For example, the barriers faced by the precast concrete industry in enhancing the sustainability of their production process include (Holton et al., 2010: 154): difficulties encountered in the recruitment and retention of skilled staff; problems faced in the supply chain due to poor payment practices and increased transport costs. These barriers can be overcome with the help of the synergies which can be created by EIPs as they enable exchange of tangible and intangible assets among the companies in the EIPs. For this reason, the advantages and driving factors for enhancing companies'

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sustainability performance [e.g. need for recycling and reusing the waste due to increased costs of and restrictions on waste disposal (Holton et al., 2010: 154)] can also become possible drivers for companies (consumers in the supply chain) to act as change agent for EID.

EIPs can support lean, resilient and sustainable supply chain management practices of the companies. These practices can affect the sustainability of the supply chain especially through "waste elimination", "supply chain risk management" and "cleaner production" (Govindan et al., 2014). As the companies having lean, resilient and sustainable supply chain management can reduce all kinds of wastes and increase efficiency, they can be motivated to work in the EIPs so that they can exchange tangible and intangible resources.

EIPs can support innovation of sustainable products and sustainable production processes as they enable exchange of tangible and intangible assets among the companies in the EIPs. Technological innovation is important in achieving sustainability (Lorek and Spangenberg, 2014: 36). Radical innovations are needed to prevent nature from breaking down under the combined pressure of human population growth and the growth in the wealth per capita (Tukker and Butter, 2007: 102). Advancement in technology leads to the new substitution possibilities, as well as to the enhanced and improved technology for extraction, use and recycling (Barnett and Morse, 1973: 11). Furthermore, "what is sustainable today may not be so ten years from now." (Parzen et al., 1996: 27). Valente (2011: 996) emphasized the importance of innovation for sustainability stating that sustainability conditions are intimately linked to the development of innovations and that non declining consumption requires resource-augmenting technical progress. Advantages of innovation include:

- adaptation of eco-innovative approaches to companies' operations (Bocken et al., 2014: 43);
- production of new environmental friendly outputs (Bocken et al., 2014: 43) (i.e. regenerative materials/constructions);
- production based on "doing more with less" idea (Nakicenovic, 1996: 1);
- "… technical change for reduction in greenhouse gases and adaptation to climate change…" (Ausubel, 1995: 411);
- enabling decarbonization (Ausubel, 1995: 411) and dematerialization both of the product, as well as of the production process enabling increase in the energy efficiency, decrease in waste generation (Herman et al., 1990: 345), as well as decrease in raw material usage (Tchobanoglous et al., 1977).

As EID enhances sustainability performance of the production process, they can support future generations' interests.

Regional development and future employability: CE can provide economic and business opportunities (the Economic and business rationale for an accelerated transition report, 2012), as well as support future jobs and competitiveness (the European Commission 2012's Manifesto for a Resource Efficient Europe). EIDs can support improvement of the regional environmental performance and economic growth (Fang et al., 2007).

Economic advantages and competitive advantage: EIPs can enhance the competitiveness of the companies in the EIPs as they enable exchange of tangible and intangible resources, collaboration and learning among the companies in the EIP. EIPs can support the companies with respect to the synergy

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created among the companies in EIPs through exchanging tangible and intangible resources; increased competitiveness of the companies in the EIPs mainly through reduced costs (i.e. usage of the resources efficiently) and increased profitability, as well as enhanced company image due to fulfilment of corporate social responsibility role with the help of environment friendly production process. EIPs can enable the companies in the EIPs to gain social, economic and ecological benefits especially through exchanges of tangible and intangible assets (Fang et al., 2007). Companies in the EIPs are motivated to collaborate due to potential economic benefits (Pakarinen et al., 2010: 1393). Collaboration among the companies can enhance their competitiveness as "…the only productive way forward is through collaboration and learning, rather than competition between different" (Tukker, 2013: 278) which can be enabled in the EIPs. EIPs can enhance the competitiveness of the companies as they support their lean and green supply chain management practices and innovation. The advantages and driving factors for enhancing companies' competitiveness [i.e. economic advantages (Vallaster and Lindgreen, 2013; Goger, 2013: 80); enhanced company image (Goger, 2013); internal branding and better communicated values in the workplace (Vallaster and Lindgreen, 2013: 298- 299); committed employees (Vallaster and Lindgreen, 2013: 298- 299); leading to long-term performance (Musson, 2012: 75); enhanced competitive advantage by i.e. lowering production costs through waste reduction and prolonged life or reuse of assets (Fiksel et al. 2004 as quoted from Hoejmose et al., 2012); upgraded value chain (Goger, 2013: 75); need for energy efficiency due to increased energy costs; need for reducing resource consumption (Holton et al., 2010: 154); enhanced organisational performance, reduced cost, and increased productivity (Aras et al., 2010; De Oliveira et al., 2010; Iraldo et al., 2009; Maletic et al. 2014; Michelon et al., 2012); differentiation for improving companies' future performance (Bose and Luo, 2011; Gupta and Kumar, 2013: 312)] can also become possible drivers for companies (consumers in the supply chain) to act as change agent for EID.

Policies and regulations: Policies and regulations can act as facilitators and as driving factors for EID in case they support EID and enhanced sustainability performance. Furthermore, governments can support the EIPs to catch the sustainability targets set in international protocols.

Barriers against EID include: unawareness of the consumers, and company specific characteristics.

Unawareness of the consumers: Individual consumers demand for sustainable products can encourage the companies to enhance their products and their production processes' sustainability qualifications whereas the individual consumers' demand not in favour of sustainable products can demotivate the companies to engage in GSCM practices (Porter and Kramer, 2006). For this reason, individual consumers of the end product need to "…recognise the roles, responsibilities and actions businesses have towards the health of the ecological environment in which businesses interact and operate (Rondinelli and Berry, 2000)" (Gupta and Kumar, 2013: 312). Companies need to persuade their customers about the initiatives they take for the welfare of society through brand communications as sustainability-based brand knowledge drives customers favourably towards the brand (Bridges and Wilhelm, 2008; Rust et al., 2004; Gupta and Kumar, 2013: 312).

Company specific characteristics: EID can encounter barriers emerged due to regulations and distrust among actors (Gibbs and Deutz, 2007; Heeres et al., 2004; Yu et al. 2014: 464); internal factors of the companies including internal politics and norms (Carter and Rogers, 2008; Govindan et al., 2014). EIPs'

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success depends on (Sakr et al., 2011: 1163): symbiotic business relationships; economic value added; awareness and information sharing; policy and regulatory frameworks; organizational and institutional setups, and technical factors.

3. Key Success Factors for EID

EID in Europe, America, North Africa and Asia Pacific regions have been analyzed to investigate the key success factors for EID and EIPs. EIDs in different countries have been presented in the following paragraphs from the EIPs developments point of views.

EIPs in Europe: There are EIPs in Europe which are in different development phases, namely in operational, pre-operational, planned, or attempted phases (Sakr et al., 2011). The EU legislation also supports the CE and EID. For example, the EU legislation's lead to the reverse logistic enterprises for remanufacturing and recycling (Fang et al., 2007: 324). This legislation can also encourage the companies to work in the EIPs. Furthermore, flexibility of regulatory requirements on performance standards (Ehrenfeld and Gertler, 1997 and Desrochers, 2001), as well as regular monitoring and evaluation of EIPs (Geng et al., 2009a), as observed in the EU, support the EID. Similarly, sustainable development in the UK is encouraged by government through the use of sectoral strategies and government policies (i.e. the National Industrial Symbiosis Program in the UK supports the EIP development in the UK) (Glass and Pocklington, 2002: 1457; Yu et al., 2014: 464). The industries in the EU, such as cement and concrete sector, tend to actively enhance their sustainability performance via the environmental management systems (i.e. ISO 14000) and integration of the sustainability related targets into the company and sectoral sustainability strategies (Glass and Pocklington, 2002: 1457). One of the well-known EIPs in the EU is the industrial symbiosis network in Kalundborg, in Denmark (Cao et al., 2009). The Kalundborg EIP provided evidence of feasibility of embedding sustainability into production process and of enhancing environmental performance of the production process. Due to water scarcity, six major companies in Kalundborg spontaneously formed a symbiotic network (Chertow, 2000; Desrochers, 2001b; Jacobsen, 2006; Pakarinen et al. 2010: 1394; Yu et al., 2014: 464). Companies in Kalundborg EIP reuse each other's waste as by-products.

EIPs in America: There are more than 60 eco-industrial networking projects in Canada and the United States, however, approximately 17 out of them are operational with completed projects (Peck, 2002; Sakr et al. 2011: 1160). Most of the EIPs in the US have been developed to foster applications of IE to industrial parks through the President's Council on Sustainable Development and US Environmental Protection Agency (Sakr et al., 2011: 1160). EIPs in Brazil are at an early stage of development (Veiga and Magrini, 2009: 660). EIPs are perceived in Brazil as a potential environmental planning strategy to foster sustainable development and to improve the degraded urban and environmental condition (Veiga and Magrini, 2009: 660). EIP development in Brazil highlighted the need for (Veiga and Magrini, 2009: 660): enhancing collaboration among governments, private institutions and industries, communities and academia; overcoming the reluctance of the state government in supporting the EIPs due to changes in political administrations and public agency leadership; and enlarging the scope of EIP idea to cover the environmental planning strategy for sustainable development.

EIPs in North Africa: As the industrial sector in Egypt is considered as vital for economic and social development of Egypt, there are approximately 80 industrial cities and zones in Egypt (IDA, 2010 as quoted

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by Sakr et al., 2011: 1159). There are, however, no EIPs in Egypt (Sakr et al., 2011: 1159-1160). The two pioneer programmes, namely the Environmentally Friendly New Industrial Cities Program (supported by the Ministry of State for Environmental Affairs) and the Integrated Industrial Solid Waste Management in Egypt project (supported by the EU LIFE Third Countries in cooperation with the Egyptian Environmental Affairs Agency) by which were targeted the improvement of environmental performance on the scale of an industrial estate, failed to meet their targets (Sakr et al., 2011: 1161-1162).

EIPs in the Asia Pacific region: During 1970s, China has transformed her planned economy to market based economy. After such transformation, foreign trade and investment has enhanced economic development (Cao et al., 2009: 2868-2876). Due to this rapid economic development, China has established EIPs in order to provide sustainable economic development (Zhu and Cote, 2004: 1025). That's why China launched EIP project in 1999, through this project industrial wastes are reduced and recycled. "The recycled materials are also used as inputs by enterprises within the park (Fang et al., 2007; Yuan et al., 2006; Zhang et al., 2010a)." (Zhang, et al., 2014: 1). After a decade in the year 2002 China's central government formally adopted the CE concept. "By 2013, 20 national eco-industrial demonstration parks had been approved, and 56 additional parks had been approved for construction (MEP, 2013)." (Zhang, et al., 2014: 1). The industrial parks that were first to adopt ecological evolution activities generally focused on sector-specific parks (e.g. sugar, electrolytic aluminium, salt-to-chemicals industry) whereas gradually, ecological evolution activities were extended to multi-sector parks (Bai et al., 2014: 5). China's government promotes EID through demonstration sites for EIPs, demonstration city and province for CE, as well as through policies, incentives, research and education (Fang et al., 2007: 327). In China, there are EIPs managed by (Fang et al., 2007: 317): enterprise groups (i.e. Guigang, Baotou, Lubei, and Fushun); the Management Commission of the Development Zone (i.e. Nanhai, Huangxing, Dalian Economic Development Zone, Tianjin Economic Development Zone); and local government (i.e. The Guiyang city and Liaoning province demonstration sites for CE). Some of the leading EIPs in China include: Guigang eco-industrial cluster (Fang et al., 2007: 318); the Guitang Group (Zhu and Cote, 2004: 1025); the Nanhai site (Fang et al., 2007: 318); the Shenyang Tiexi New District (Fang et al., 2007: 318); the Dalian economic and technology development zone (Fang et al., 2007: 318 and Bai et al., 2014: 5).

South Korea's EIP development strategy is based on the transformation of the industrial complexes into EIPs. EIP initiatives have been launched in 2005 (Jung et al., 2013: 50) and embarked by the Ministry of Knowledge Economy. Daedok Technovalley Development Project was the Korea's first attempt to design EIP by restructuring a conventional industrial estate development plan (Oh et al., 2005: 269). The South Korean EIP development plan consists of three phases as (Jung et al., 2013: 50-59):

- The first phase (2005-2009) covered pilot projects for transforming industrial complexes into EIPs. Furthermore, environmental education and awareness campaigns were conducted (Park et al., 2008).
- The second phase (2010-2014) aimed to widespread the dissemination of the EIP concept to industrial parks and to increase the quantities of EIPs.
- The third phase (2015-2019) is planned to analyse the lessons learnt from the previous two phases and would be fed back into the system/plan.

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EIPs developments in Europe, America, North Africa and Asia Pacific revealed the importance of the following key factors for EID:

- laws and legislation supporting reverse logistics, sustainable development (Fang et al., 2007);
- flexibility of regulatory requirements on performance standards (Ehrenfeld and Gertler, 1997 and Desrochers, 2001), as well as;
- regular monitoring and evaluation of EIPs (Geng et al., 2009a);
- governments' supports;
- sectoral strategies and government policies (i.e. the National Industrial Symbiosis Program in the UK supports the EIP development in the UK) (Glass and Pocklington, 2002: 1457; Yu et al., 2014: 464);
- enhancing collaboration among governments, private institutions and industries, communities and academia; overcoming the reluctance of the state government in supporting the EIPs due to changes in political administrations and public agency leadership; and enlarging the scope of EIP idea to cover the environmental planning strategy for sustainable development (Veiga and Magrini, 2009: 660);
- launching pilot EIPs.

4. Discussion

Promoting sustainable production is among the objectives of sustainable development (UN, 2002; Barber, 2007: 499). CE, IE and EID play important role in the sustainable development as they support sustainable production (Lorek and Spangenberg, 2014) and as companies are perceived as major contributors to ecological problems (Clifton and Amran, 2011; Roy and Goll, 2014: 851-852). For this reason, EID needs to be fostered and the companies need to be encouraged to act as change agents for sustainability producing in the EIPs and supporting EID. In this way, environmental footprint of the production processes can be minimized and companies can get benefit from producing in the EIPs (e.g. improvement of the sustainability performance; economic advantages and competitive advantage). Furthermore, social benefits can be obtained (e.g. regional development and future employability) supporting sustainable development. Companies, however, can encounter barriers (e.g. unawareness of the consumers, and company specific characteristics). Consumers' awareness for sustainable products and importance for sustainable production processes can affect their demand for the products of the companies in the EIPs. For this reason, enhancing consumers' awareness through formal or informal education, and media plays important role in increasing their demand for sustainable products encouraging the companies to invest in sustainable production processes and in producing in the EIPs. Consumers' demand for sustainable products and companies' willingness to produce in the EIPs can be encouraged by relevant laws and regulations. Furthermore, countries' policies need to encourage EID benchmarking from past experiences of the countries where EID has been successfully achieved. Factors which need to be considered by the countries and their policymakers wishing to widespread the EID have been summarized in the Table 1.

Table 1: Factors for encouraging the EID and sustainable development

Factors	**References**
Countries need to establish laws and legislation supporting reverse logistics,	Fang et al. (2007)

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sustainable development.	
Laws and regulations need to encourage consumers' demand for sustainable products and companies' willingness to produce in the EIPs.	
Laws and regulations need to provide flexibility of regulatory requirements on performance standards.	Ehrenfeld and Gertler (1997), Desrochers (2001)
Countries need to perform regular monitoring and evaluation of EIPs.	Geng et al. (2009a)
Countries need to encourage collaboration among governments, private institutions and industries, communities and academia, as well as sectoral strategies and government policies; and to provide steady political environment for development of EIPs.	Glass and Pocklington (2002: 1457), Veiga and Magrini (2009: 660), Yu et al. (2014: 464)
Countries need to launch pilot EIPs.	
Consumers' awareness for sustainable products and importance for sustainable production processes need to be enhanced through formal or informal education, and media plays important role in increasing their demand for sustainable products.	
Eco-labelling need to be supported as they provide consumers information about the environmental impacts of products.	Reczkova et al. (2013: 498)
Countries' policies need to encourage EID benchmarking from past experiences of the countries where EID has been successfully achieved.	
International collaboration is needed to reduce environmental footprint of the production processes and to enhance EID.	

5. Conclusions

This paper focuses upon the EID as a key for reducing environmental footprint of production. Based on an in-depth literature review, this paper analyses the need for the EID; sustainable development enhanced by sustainable production and sustainable products; as well as key success factors for, barriers against and drivers for the EID.

The world's habitat is being deteriorated especially due to the unsustainable production and consumption. There is an increase in the global consumption of natural resources (Rohn et al., 2014: 32). CE and IE enhanced by the EID need to be encouraged for reducing humanities' environmental footprint. CE, IE and EID can support sustainable society which relies on sustainable consumption, as well as on sustainable production (Lorek and Spangenberg, 2014). For this reason, companies acting as change agents are needed to foster the EID. Facilitators for transformation of companies into change agents for EID include: eco-labelling, policies and government.

- Eco-labelling: Eco-labelling influences the individual consumers' demand for the end product, as well as the demand of the companies in the supply chain for sustainable/environmental friendly input materials or by-products. Eco-labelling encourages sustainable production which can be enhanced by increased synergy among the companies in the EIPs so that they can reduce their environmental footprints.
- Policies and governments: Policies and governments can act as facilitators and as driving factors for EID. Policies should encourage the citizens' involvement to increase their effectiveness.

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Drivers for companies to act as change agents for EID include: improvement of the sustainability performance; regional development and future employability; economic advantages and competitive advantage; policies and regulations.

- ***Improvement of the sustainability performance:*** The requirements for improvement in the sustainability performance of the production process and of the products encourage the companies to work in the EIPs. EIPs can support lean, resilient and green supply chain management practices of the companies, as well as innovation of sustainable products and sustainable production processes as they enable exchange of tangible and intangible assets among the companies in the EIPs.
- ***Regional development and future employability:*** EIDs can support improvement of the regional environmental performance and economic growth (Fang et al., 2007).
- ***Economic advantages and competitive advantage:*** EIPs can support the companies with respect to the synergy created among the companies in EIPs through exchanging tangible and intangible resources; increased competitiveness of the companies in the EIPs mainly through reduced costs (i.e. usage of the resources efficiently) and increased profitability, as well as enhanced company image due to fulfilment of corporate social responsibility role with the help of environment friendly production process. EIPs can enable the companies in the EIPs to gain social, economic and ecological benefits especially through exchanges of tangible and intangible assets (Fang et al., 2007).
- ***Policies and regulations:*** Requirements of the laws and regulations for environmental friendly production and products can act as facilitators and as driving factors for EID. International protocols and agreements on sustainability targets can enable the governments to encourage EID as well.

Barriers against EID include: consumers who do not demand for or who are not aware of the sustainable products or sustainable production process, and company specific obstacles (e.g. regulations; working culture; organizational structure).

The governments are recommended to consider the key success factors for the EID so that they can widespread EIPs. Based on analysis of the EIPs' developments in Europe, America, North Africa and Asia Pacific, the following key factors for EID have been revealed:

- Governments should be keen in supporting EID.
- Governments should prepare laws and legislations which support reverse logistics, sustainable development (Fang et al., 2007).
- Governments should provide flexibility in regulatory requirements with respect to the performance standards (Ehrenfeld and Gertler, 1997 and Desrochers, 2001).
- Governments should establish a system for regular monitoring and evaluation of EIPs (Geng et al., 2009a), as well as sectoral strategies and government policies (i.e. the National Industrial Symbiosis Program in the UK supports the EIP development in the UK) (Glass and Pocklington, 2002: 1457; Yu et al., 2014: 464).
- Governments should encourage collaboration among governments, private institutions, industries, communities and academia (Veiga and Magrini, 2009: 660).
- Governments can start the EID launching pilot EIPs.

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Furthermore, the governments are recommended to consider the facilitators for transforming the consumers into change agents for EID as their policies' effectiveness can be enhanced with the help of citizens' involvement in the process. The governments are also recommended to consider the driving factors for and barriers against the EID so that they can take necessary precautions on time. Wide-spreading EID throughout the world can support the sustainability performance of the production processes reducing environmental footprint of the humanity. For this reason, international collaboration on how to support and encourage establishment of EID needs to be fostered. Further researches are recommended to be carried out on political aspects of the EID at the international level focusing on how to motivate governments in establishing EIPs and the companies to operate in the EIPs, as well as on the international laws and trade regulations needed to drive establishment of the EIDs worldwide.

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