

Article

## Tourism Management and Industrial Ecology: A Theoretical Review

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Received: 11 July 2014 / Accepted: 23 July 2014 / Published: 4 August 2014

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**Abstract:** Industrial Ecology (IE) is based on the relation between the natural ecosystem and economic ecosystem. The concept refers to the metaphorical relation between the natural and industrial ecosystems as a model for transforming unsustainable industrial systems. Several tools and strategies are particularly significant for the IE development. In other words, the primary purpose of industrial ecology is to assess and reduce the impact economic activities on the environment. Tourism, as an economic activity, resulting in a full range of environmental impacts, should be treated like any other industry. This paper propose uses a theoretical review focused on IE for to investigate what is the best way to implement industrial ecology in the tourism activities. It seemed interesting to search within the IE concept for a model for the tourism sector, one of the fields with the greatest environmental interaction and economic implications.

**Keywords:** tourism management; IE; innovative strategy; eco-innovation; sustainability; European policy

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### 1. Introduction

The concept of “sustainability” comes from the scientific literature that defines the management of a resource as sustainable if its exploitation does not exceed a certain threshold defined as critical natural capital [1]. Sustainability’s application to corporate management strategies arise from the phenomena of IE and industrial symbiosis.

The IE Concept refers to the metaphorical relation between the natural and industrial ecosystems as a model for transforming unsustainable industrial systems [2]. The IE aims to analyze systematic interactions between economic and environmental needs for structured settlement and collective environmental problems. Industrial symbiosis refers to the network of product, by-product and waste exchanges that reduce the ecological footprint of industrial areas. Models of development of industrial networks through symbiosis are spread all over the world to demonstrate that the benefits of them and the opportunities for economic and ecological efficiency are proven. However, it is generally recognized that the actual benefits or opportunities for improvement that these models generate must be evaluated [3,4].

At the same time, there are currently no specific models for the industrial sector and examples consolidated in the tourism sector, which are applied to a model of evaluation of the actual economic benefits from the symbiosis itself [5]. For this reason, it is useful to classify and study the major publications in the literature on the subject in order to find or create a model to assess the unique benefits and opportunities in an attempt to develop an integrative assessment methodology for projects' industrial symbiosis, and specifically for projects involving tourism activities.

## 2. Literature Review: Industrial Ecology Concept

In the literature, there are several definitions of the IE holistic concept. In 1992, Frosch [6] introduces the concept of analogy between natural and industrial ecosystems and, in the same period Ayres [7] elaborates the metaphor of the biosphere/technosphere to explain the concepts of ecology and industrial metabolism. When, in 1992, Jelinski conceptualized IE in three development models, he explained that the model by Korhonen and Strachan (2004) could be defined as a linear model, which is not mature and unsustainable [8,9]. The second class of IE models could be defined as a semi-matured model, because it is more advanced than linear models but still unsustainable. Finally, Korhonen in 2005 realized the mature and materially closed ecosystem model [7,10].

In particular, in 1997, Erkman, in a careful review and classification of the authors, has identified three elements including splitting the definitions of the concept [11]. The first classification is based on the systemic approach. In this case, the company system was integrated with the external system which includes the material and energy flows, rather than studying each component of the system.

The second classification of definitions of IE takes into account the material and energy flows inside and outside the company as if it were a larger system.

Finally, technology is also included as a key component essential to achieve the transformation from an industrial system in practicing a sustainable industrial ecosystem. In 1999, Richards and Galdwin identified the characteristics necessary for the right indicators [12].

The qualities that the indicators must have are:

- Relevance: Ensuring that the entrepreneurs consider the indicators selected important to their future and in their decision-making.
- Practicability: Ensuring that the measurement and monitoring of the indicators is practical, reliable and within the resources available to the business.
- Appropriateness: Ensuring that the indicators reflect actual environmental impacts, and coincide with the company's long-term aims.

Based on the Danish experience, excellently retold in a bibliography by Ehrenfeld *et al.* in the paper “Industrial Ecology in Practice The Evolution of Interdependence at Kalundborg” for MIT Institute and published for the first volume of the Journal of Industrial Ecology, many researchers have based their studies on this subject. In the study, the authors explained how the small industrial area of Kalundborg has developed spontaneously and gradually as a collaborative network of seven industries and how the city administration, with the goal of making economical use of by-products, has thus reduced costs to comply with new environmental regulations that were always more restrictive [3,13].

Through a series of bilateral trade agreements, Kalundborg has managed over the years to achieve significant tangible benefits which have not only benefited companies in economic terms, but also the population and the environment. There has been a reduction in pollution, a reduction in the consumption of resources such as water, coal, oil and other, better use of energy resources and reuse of waste, used by other companies as raw materials [12,13]. Thereafter, Christensen (2000) suggests a number of preconditions for the success of industrial symbiosis [14]:

- The industries core business must be different. They are not competitors but complement each other in their materials production and use;
- The bilateral agreements must be voluntary and make economic and commercial sense;
- There must be a close proximity between the industrial partners to enable effective transportation of materials;
- The management at the different industries must build a personal rapport;
- The community must be small enough that they all feel that they have a stake in the outcomes (important stakeholders role).

In 2001, Korhonen argues that the objective of an evolved IE system is to switch from linear to cyclic flows in a situation where the resources of life are limited and, therefore, the system operates to almost complete the cyclical nature of the flows of material [14].

In 2005, the same author discussed the theories that suggest we should model an even more advanced linear recording of the lack of development on the deficient public policies and not mature implementation of the corporate responsibility concept, emphasizing that cooperation between public and businesses it is very important for the creation of a cohesive system [10].

For Renner, the main issue of implementing an industrial ecological system depends on two factors: the geographical location and the type of industrial activity that should mainly be performed. Six component elements of industry are required: Raw material, Market, Labor, Power, Capital and Transportation. The industrial interrelationship between these factors is often complicated to analyze. Chief among these is the phenomenon of industrial symbiosis. By this is meant the consorting together of two or more dissimilar industries. Industrial symbiosis, when scrutinized, has been seen to be of two kinds, disjunctive and conjunctive, depending on the distance between the industries [15].

In contrast, for Chertow (2003) the main issue is focused on planning: the objectives set in the planning process of the industrial ecological system and the results we want to achieve are the basis of all subsequent stages [16].

However, also for Chertow, in his previous studies, the emerging field of IE demands resolute attention to the flow of materials and energy through local, regional and global economies [17]. In one of his major studies, while studying the analysis of the two eco-industrial parks in the United States,

Chertow (2003) realized that the objectives and components of the project were clear. These were only applicable to certain types of projects but could be modified and adapted to different types of industrial symbiosis [18].

The principles of valuation of the author led to the following assessment criteria: examination of the design standards adopted, enhancement of the common benefits, measurement of the benefits of each company and analysis of different market pressures. In later years, however, other authors manifested different opinions about IE and Symbiosis. In 2004, Mirata, for example, claims that Industrial Symbiosis initiatives offer the potential for environmental, economic and social benefits.

He also states that there is no agreed upon success criteria regarding the development of IS initiatives and there is very limited evidence of initiatives taken to evaluate the industrial symbiosis initiatives [19]. Kurup, instead, in 2005, developed a set of indicators based on the triple bottom line accounting, allowing for improved identification and reporting of the economic, social and environmental benefits of industrial symbiosis projects [4].

### 3. Applications and Examples from Italy

The European Union pushes a potential production system based on IE. At European level, with a series of initiatives including, e.g., the initiative “A resource-efficient Europe—Flagship initiative of the Europe 2020 Strategy” and the “Raw Materials Initiative”, green economy must demonstrate efficient procurement and sustainable use of resources. This principle has been highlighted, even from the strategic point of view [20,21]. In Italy, one of the first examples of IE was prepared by the Chemistry of the Province of Mantua, who proposed that the major companies in the area should participate in the project “Industrial Ecology in the Province of Mantua”.

The aim of the project was to introduce the culture of sustainable development in industries valances and strengthen the chemical industry [3]. Another example of IE (inspired by the knowledge network principles) is the project of Platform of Industrial Symbiosis in Sicily. It as part of the aforementioned project Eco-Innovation Sicily coordinated by ENEA, the aims of which include the interconnection between traditionally separate contacts (network), the knowledge of the opportunities available (databases), also on the basis of the needs and special characteristics of each user (cooperative databases), and using the availability of expert skills to understand and propose solutions to industrial symbiosis (expertise) [3]. Other examples are present in the Abruzzi and Tuscany regions [22].

In the Italian context, in addition to the chemical industry and the eco-industrial parks, IE could be applied to various fields, including the energy sector, the waste treatment and management, and the building sector. In particular, for the regional characteristic of the territory, many systems based on the principles of IE can be implemented for the agri-food and for the tourism sector.

### 4. Tourism Sector Sustainability: The Scenario

Tourism is a multifaceted sector, characterized by the combination of actions and behaviors around several areas as energy, agriculture, transport, *etc.* This is the reason that the sector’s relationship with sustainability has gradually consolidated, given the increasing importance of consumption and its environmental impacts [23,24]. Tourism has been defined as “... the sum of the phenomena and relationships resulting from travel and stay of non-residents...” [25]. Even if mass consumption is

endangering the future of our world in many different ways—and tourism has significantly contributed to this situation—tourism development can also bring extensive benefits to society.

In an attempt to promote sustainable practices, different kinds of eco-labeling in this sector have been developed [26].

Sustainability appears to be a key business variable for tourism for this reason, it is an integrated part of business strategy of this market's actors [27]. As evidence of this, data on the European Regional Policy for tourism shows that, from 2007 to 2013, EU support for tourism under Cohesion Policy amounting to more than EUR 6 billion is planned (1.8% of the total). In total, EUR 3.8 billion is allocated for the improvement of tourist services, EUR 1.4 for the protection and development of natural heritage, and EUR 1.1 billion for the promotion of natural assets. In addition, support for tourism-related infrastructure and services can be provided under other headings, such as innovation, promotion of small and medium-sized enterprises, information technology applications and human capital [28]. An important number of sustainable transnational thematic tourism products and services has been developed and has a great potential to contribute to tourism growth.

A large number of projects were funded to stimulate competitiveness in the European tourism sector and the European Commission encourages diversification of the supply of tourist services and products. By supporting projects promoting sustainable thematic tourism products, the EU aims at trans-national cooperation with regard to sustainable tourism, encouraging an elevated involvement of small and micro enterprises and local authorities and motivating competitiveness of the tourism industry by funding an enhanced focus on the diversification of sustainable thematic tourism products [29]. In particular, the European Union Report on Tourism 2013, observed for Italy the implementation of the tourism sustainable strategy for economic prosperity, social equity and cohesion and environmental and cultural protection.

In 2012, a wide campaign was conducted to promote 30 EDEN destinations selected in the Italian territory for the development of sustainable tourism models and suggest alternative to mass tourism. Twenty-one destinations and have been selected to receive help to enhance their environmental, cultural, and culinary life as part of the Project “Gioielli di Italia”.

These programs must be integrated into Industrial programs, especially in Industry 2015 projects on sustainable mobility, which are being carried out by consortia which include a total of 250 companies and 100 research centers, for a total amount of 180 million euro [30]. The “*Flagship projects*”, which aim to enhance regional and interregional tourist routes characterized by strong historical, cultural and religious elements also improve the quality of life of the local territorial communities. Projects help to improve the performance of tourism enterprises, minimizing the use of resources and production of waste in order to promote the quality in the provision of tourist facilities, evaluate and monitor the quality of the accommodations facilities and improve the general tourism quality. Finally, the creation of regional and interregional tourist itineraries related to land resources establishes a strong link with the local food and wine industry [31].

## 5. A Pattern of Industrial Ecology in Tourism

Tourism can be a catalyst for national and regional development, bringing employment, exchange earnings, balance of payments advantages and important infrastructure developments benefiting locals

and visitors alike [32,33]. The studies “Some Fundamental Truths about Tourism”, published in the Journal of Sustainable Tourism, and written by McKercher in 1993 summarizes eight principles that describe the business relationship between tourism and the environment [34]:

- As an industrial activity, tourism consumes resources, creates waste and has specific infrastructure needs.
- As a consumer of resources, it has the ability to over consume resources.
- Tourism, as a resource dependent industry must compete for scarce resources to ensure its survival.
- Tourism is a private sector dominated industry, with investment decisions being based predominantly on profit maximization.
- Tourism is a multi-faceted industry, and as such, it is almost impossible to control.
- Tourists are consumers, not anthropologists.
- Tourism is entertainment.
- Unlike other industrial activities, tourism generates income by importing clients rather than exporting its product.

An interesting study by Saito (2013) presented survey results on resource use and waste generation by the tourism industry on the Island of Hawaii [35]. From this is possible to categorize flow, emission and consumption of resources that relate to the main activities that the tourist performs (Table 1). The classification can be conducted per establishment, per employee, per visitor or per room.

**Table 1.** Classification of flows and activities related to tourism [35].

Flows	Activities	Imputation-based analysis
Recourse consumption	Food inventory	Per establishment
Waste generation	Beverage Inventory	Per employee
Energy consumption	Accommodation and Services	Per visitors
	Restaurant	Per room service
	Tours	

However, the indicators that must be taken into account when designing and evaluating a robust classification are: economic, environmental and social. In fact, Kurup (2005) has emphasized that the economic, social and environmental implications need to be considered for each stage of the synergy project life cycle (*i.e.*, planning, design, construction, operation, maintenance and decommissioning) and listed the indicators for each dimension (Table 2) [3].

**Table 2.** Industrial Ecology Indicators [3].

Economic	Environmental	Social
Generate local business opportunities	Land use	Job creation
Generate capital works	Biodiversity	Job security
Sail	Energy consumption	Health and well being
Profit	Water consumption	Community stability
Wages paid	Air, land and water emissions	Education standards
Taxation revenue	Material consumption	Community services
Tangible environmental costs		Crime rates
Transport costs		Sensory stimuli

Finally, with the help of the European Indicator Toolkit for tourism (2013) we have tried, matching the indicators from the study of the literature of IE, to create a specific pattern of IE indicator focused on tourism [36]. The interesting new feature of the toolkit is that it included a Destination Profile Description which, by collecting data in the field using interviews outlines the characteristics of what could become a “tourist park”.

In addition to this, we specify all categories of stakeholder involved and outline the profile with the same methodology. Indicators are divided into two categories: core and optional. Each category has four classes of indicators: destination management indicators, economic value indicators, social and cultural impact indicators. Environmental impact indicators are shown in Table 3.

**Table 3.** Industrial Ecology Indicators for tourism pattern.

<b>Destination Management</b>	<b>Economic Value Indicators</b>	<b>Environmental Impact Indicators</b>	<b>Social and Cultural Impact Indicators</b>
Sustainable Tourism Public Policy	Tourism Flow (volume and value) at Destination	Reducing Transport Impact	Community/Social Impact
Sustainable Tourism Management in Tourism Enterprises	Quantity and Quality of Employment	Climate Change	Gender Equality
Customer Satisfaction	Safety and Health	Solid Waste Management	Equality/Accessibility
Information and Communication	Tourism Supply Chain	Sewage Treatment	Protecting and Enhancing Cultural Heritage, Local Identity and Assets
		Water Management	
		Energy Usage	
		Landscape and Biodiversity Protection	
		Light and Noise Management	
		Bathing Water Quality	

These indicators can be used as evaluation indicators that, moreover, coincide in part with those already identified and adopted by Kurup (2005) and reported in the paper of Agarwal and Strachan (2006) [3,37,38]. In conclusion, Fons *et al.* (2004) suggested a model to ascertain whether the IE project is going to provide a net positive benefit to the companies and to the local community. A fuzzy cognitive map (FCM) approach is suggested for the impact assessment [39].

The advantage of this approach is that it not only covers direct impacts but also takes into account indirect effects or interaction between impacts.

## 6. Concluding Remarks

A review of the literature and studies being done shows much research that relates tourism with ecology, the tourism sector and its environmental impacts, and sustainable tourism. However, this changes depending on whether the search is specific to the applied IE model or involves tourism. The

research relating to the tools of IE is different to that applied to the industry sector: there are more implementations of analysis and application of the proper tools of IE (LCA, Ecological Footprint, Eco-Design, environmental conservation techniques, carrying capacities assessment, *etc.*) [40].

The European Tourism Indicator System for Sustainable Management at Destination Level is one of the key initiatives to contribute to improving the sustainable management of destinations by providing tourism stakeholders with an easy and useful toolkit [37].

The main problem, more specifically to Italy, also demonstrated by the results of this research, is that there is not a real and structural planning for the tourism sector. However, this should be mandatory [41].

Furthermore, an assessment of tourism's contribution to economic development in host regions requires an analysis of the backward and forward linkages between tourism and other sectors, an understanding of the spatial location of tourism activities and identification of the beneficiaries of its economic and other impacts.

### Author Contributions

These authors contributed full and equally to this work. Both author contributed to research design. Gabriella Arcese analyze the source and literature. Maria Claudia Lucchetti coordinated and supervised the research project and carried out a detailed revision. Both authors wrote the body of the paper, read and approved the final manuscript.

### Conflicts of Interest

The authors declare no conflict of interest.

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