Tourism management and industrial ecology: a case study of food service in Taiwan

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Abstract

The main purpose of industrial ecology is to evaluate and minimize impacts from economic activities. Tourism, as an economic activity, results in a full range of environmental impacts and should be regarded as any other industry. Hence, the application of industrial ecology in tourism was investigated to enhance environmental management of catering. More specifically, boxed food in Taiwan was taken as a case study to demonstrate this new approach.

The framework for studying boxed food was based on material flow analysis. Boxed food analysis can be divided into two parts: the meal box and the contents. Meal boxes were inventoried with a life cycle assessment (LCA). According to the findings of this study, environmental impacts from a PP meal box production were more expensive than others, while those from a PS meal box production were the lowest. The life cycle inventory analysis of the contents will be investigated with a new approach system in the next phase of our work. This new approach is an integration of the LCA with the Hazard Analysis Control Point (HACCP) system.

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1. Introduction

Tourism development has become a major policy of the government of Taiwan to increase employment and economic growth. However, tourism has long been regarded as having environmental impacts (Mathieson & Wall, 1982; Mieczkowski, 1995; Holden, 2000) and results in a full range of such impacts and should be regarded as any other industry, especially in natural or semi-natural environments (Young, 1973; Gunn, 1994). The evident need for environmental planning and management of tourism is of concern to governments, non-governmental organizations (NGOs), local communities and the private sector (Holden, 2000). A variety of measures are encouraged to mitigate the negative effects of tourism, measures such as zoning of land-use, carrying capacity analysis, limits of acceptable change (LAC) and environmental impact assessments (EIA), but they are often used to deal with issues concerning outdoor recreation and few relate to catering management.

The main purpose of industrial ecology is to evaluate and minimize impacts from economic activities. As applied in manufacturing, it involves the design of industrial processes, products and services from the dual perspectives of product competitiveness and environmental concerns. A full consideration of industrial ecology would include the entire scope of economic activity, encompassing mining, agriculture, forestry, manufacturing, service sectors and consumer behavior. Tourism as one economic activity, results in a full range of environmental impacts, but few applications of industrial ecology to tourism management have previously been discussed.

Hence, the application of industrial ecology within tourism was investigated in this paper to enhance the environmental management of catering. Industrial ecology has become an important tool for linking industrial activity and environmental and social
1.1. Industrial ecology (IE)

Industrial ecology (IE) is the means by which humanity can deliberately and rationally approach and maintain sustainability, given the continued economic, cultural and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a system view in which one seeks to optimize the total materials cycle, from virgin material to finished material, to component, to product, to obsolete product and to ultimate disposal (Graedel & Allenby, 2003). One of the most important concepts of industrial ecology is that, like the biological system, it rejects the concept of waste. Waste is defined as useless or worthless material in human society. In nature, however, nothing is eternally discarded; in various ways all materials are reused, generally with great efficiency.

Material flow analysis (MFA) is the basic framework of IE. Based on the analysis of materials and related energy flows, IE attempts to identify technical and management options that promise more efficient resource use and less environmental impact. Like biological ecologists, industrial ecologists analyze systems that form the context for the flow of materials and energy as well as the mechanisms that govern them. To understand the context for implementing improvements, IE thus also considers institutional and commercial barriers as well as regional strategies for more efficient material use (Wernick & Ausubel, 1997). IE posits that better economic and technological understanding of industrial systems can in fact lead to more efficient and less wasteful material flows that benefit the economy and natural environment (Erkman, 1997).

1.2. Tourism industry and boxed food in Taiwan

Tourism development has recently become a major policy initiative of the Taiwanese Government, to increase employment capacity and economic growth, after many traditional industries moved into China. For example, the Doubling Tourist Arrivals Policy is proposed by the Executive Yuan (the highest administrative organ of Taiwan), and its goal is to double the number of tourists visiting Taiwan in 2008 (Executive Yuan, 2001). According to the data from the Tourism Bureau of Taiwan, the number of tourists who visited Taiwan in 2002 is 2,726,411 and its growth rate is 4.18% (Tourism Bureau of Taiwan, 2003). This generates 4,197 million US $ in receipts and the expenditure growth rate is 5.2%. In addition, there are 252 destinations for tourism in Taiwan and they attracted about 102,717,932 domestic visitors in 2002. Such numbers further develop, as well as and related industries such as hotels, transportation and food service companies, but negative environmental impacts also occur at the same time. For example, waste treatment has become a serious problem in many destinations of Taiwan (Kuo & Yu, 2001).

Boxed food is a convenient means of food supply when tourists are on the road. It always consisted of rice, meat (e.g. pork or chicken) and three or four kinds of vegetables in a meal box in Taiwan. This food service not only can save time but also avoid missing meal time while on a tour schedule. Most mass tourism in Taiwan uses boxed food for lunch, especially when tourists are traveling to the next destination. In addition, tourists enjoy eating boxed food on the railway and it has become an important tourism image of railway tourism in Taiwan, called ‘railway boxed food culture’. According to the data from the Taiwan Railway Administration, more than 4,000,000 pieces of boxed food are sold per year and the number keeps growing. In conclusion, boxed food (boxed lunches) provision is a main form of food service in Taiwan and it also becomes a special tourism issue that should be investigated further. In particular, boxed food service will result in environmental impacts, the same as other food service, and these negative impacts should be identified and evaluated.

Three main types of meal boxes used in Taiwan are cardboard, PS and PP. The cardboard meal box is mainly made of paper. The PS meal box is made of polystyrene, while the PP meal box is made of polypropylene. According to the data from the Taiwan EPA, the amount of waste PS and PP meal boxes is 43,000 tons per year, and that of waste cardboard meal boxes is 16,000 tons per year. Both the low recycle rate (about 15–20%) and the difficulty of treating these recycled boxes cause a serious environmental problem in Taiwan.

2. Methods

The framework for studying boxed food was based on the material flow analysis (MFA) of industrial ecology (IE) and is shown in Fig. 1. MFA is an analysis of the flow of materials within and across the boundaries of a particular geographical region. Boxed food analysis can be divided into two parts: one part is the meal box (containers) and the other is the contents (rice, meat, and vegetables). Firstly, meal boxes are inventoried with material flows, IE thus also considers institutional and commercial barriers as well as regional strategies for more efficient material use (Wernick & Ausubel, 1997). IE posits that better economic and technological understanding of industrial systems can in fact lead to more efficient and less wasteful material flows that benefit the economy and natural environment (Erkman, 1997).
environmental burdens associated with a product, process or activity by identifying and quantifying energy and material usage and environmental releases, to assess the impact of the energy, material uses and releases on the environment, and to evaluate and implement opportunities to effect environmental improvements (Curran, 1996).

The life cycle inventory analysis was carried out with the Boustead model. The Boustead model comprises two parts. The first is the extensive database, in which data such as fuels and energy use, raw material requirements, solid waste, liquid and gaseous emissions are stored. The second part is the software, which enables the user to manipulate data in the database and to select a suitable data presentation method from a host of options (Benedetti, Badino, & Baldo, 1996; Hsiao, 2002).

3. Results

The weight of one meal box was surveyed first and then could be used for impact assessment and evaluation. The average weight of cardboard, PS, and PP meal boxes is 21.3, 5.1, and 27.2 g/piece, respectively. A life cycle inventory analysis was then carried out within Taiwan and the final results were shown in Table 1. The materials and energy requirements of a meal box production were inventoried: such as petroleum, coal, liquid natural gas (LNG), water and energy in terms of per meal box. Furthermore, the environmental pollution resulting from meal box production was also considered in the categories of air pollution, water pollution and waste generation. The amount of various air pollutant emissions was measured: such as nitrogen oxides (NO\textsubscript{x}), sulfur oxides (SO\textsubscript{x}), particulates, carbon dioxide (CO\textsubscript{2}), methane (CH\textsubscript{4}) and hydrocarbons (HC). In the category of water pollution, the amount of chemical oxygen demand (COD), biochemical oxygen demand (BOD), suspended solid (SS), and nitrogen discharge was calculated in terms of per meal box. Finally, the amount of waste generation per meal box was also investigated and is shown in Table 1.

In order to interpret environment impacts more clearly and simply for the public, methods derived from environmental economics are usually used. The most convenient approach is based on environmental cost analysis with the results shown in unit of dollars. The available data for calculating the environmental cost of per meal box production were surveyed as far as possible and are shown in Table 2. In Taiwan, the data for air pollution control are available only about nitrogen oxides (NO\textsubscript{x}), sulfur oxides (SO\textsubscript{x}) and particulates, but not about carbon dioxide (CO\textsubscript{2}) and hydrocarbons (HC). Similarly, environmental cost data of water pollution control are available only about COD and SS.

The total environmental cost of per meal box production was calculated with the available data list in Table 2 and the final results are shown in Table 3. In terms of energy and materials requirements, and air pollution control, the environmental cost of per PP meal box production is the most expensive. It costs 1.449, and
In contrast, in terms of water pollution control and waste treatment, the environmental cost of per cardboard meal box production is the most expensive. It costs 0.023891, and 0.017686 NT $, respectively. Finally, the sum of these four kinds of environmental cost was added. The total environmental cost per PP meal box production is the most expensive (1.4664 NT $), while PS meal box production would cost the least (0.3354 NT $).

4. Discussion

According to the results of the life cycle inventory analysis, some differences among these three kinds of meal boxes were found. First, in terms of energy and material requirements, the PP meal box production needs more energy, petroleum, coal, liquid natural gas (LNG) and water than others, while the cardboard meal box production needs more coal than others. In addition, the PP meal box production emits more air pollution than others in terms of nitrogen oxides (NO\(_x\)), sulfur oxides (SO\(_x\)), carbon dioxide (CO\(_2\)), and hydrocarbons (HC), while the cardboard meal box production emits more particulates and methane (CH\(_4\)) than others. It is worth noting that the amount of carbon dioxide (CO\(_2\)) emission from cardboard meal box production is negative, because the raw materials of a cardboard meal box is from trees and the amount of CO\(_2\) that trees absorbed is larger than that emitted from the production processes.

The cardboard meal box production process seems to discharge more water pollution than others. The amount of COD, BOD, and SS resulting from the cardboard meal box production is about twenty to a hundred times that of others. Only in the nitrogen item does the
PP meal box production discharge more than others. Moreover, in terms of waste, the cardboard meal box production process generates more waste than others and the amount reaches 2.8 g per cardboard meal box.

According to the findings of this study, the environmental impact from the PP meal box production is more serious than from others. The total environmental cost of per PP meal box production is 1.4664 NT $, while per cardboard, and PS meal box production is 0.6386, and 0.3354 NT $, respectively. To decrease the impacts, the idea of the ‘polluter pays’ principle (PPP) might be adopted as an important management strategy. One approach is to internalize the costs of environmental impact into the operating costs of container producers, food boxed companies, and tour operators in forms of a tax or fine. Another approach is to discourage the tourist from using boxed food with an additional fee being levied.

This is the first part of an environmental impact analysis of boxed food and is restricted to containers. Another part is the contents (rice, meat, and vegetables) and will be investigated in the next phase of our work. The quantitative data to establish the levels and types of energy and materials used in the content production and the environmental releases that result are not available at present. A new idea to collect these quantitative data through the Hazard Analysis Critical Control Point (HACCP) system is proposed here. The HACCP system is developed for food safety management and its standard operation procedure is well known in the food industry (Loken, 1995).

Since implementing the HACCP system is required under food hygiene regulations by the government of Taiwan, every boxed food supply company has established the standard operation procedure of the HACCP system in their factory. If the life cycle inventory analysis can be integrated into the operation procedure of the HACCP system (Table 4), it will be easy to collect quantitative data for LCA. This integration system will allow inspectors to simply input life cycle inventory data, while they write down the food sanitation inspection records. The life cycle inventory analysis of the contents (rice, meat, and vegetables) of boxed food will be studied with this integration system in the next phase of our work.

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5. Conclusions

The main purpose of industrial ecology is to evaluate and minimize impacts from economic activities. Industrial ecology has become an important tool to seek sustainable development for industries. Even if most application cases of industrial ecology are about manufacturing, the tourism industry may become one of the applications of IE. The application of industrial ecology within tourism was investigated in this research in order to enhance the environmental management of catering. Food services, in particular, boxed food in Taiwan was successfully studied with this approach. Moreover, industrial ecology might become an important research topic for tourism management in the future.

The life cycle inventory analysis of the contents of boxed food will be investigated with a new approach system in the next phase of our work. This new approach is an integration system of the LCA with the HACCP system, which is designed for food safety management. By using the systematic frame and operation, this system might not only increase quality of product, but also decrease negative environmental impacts, together with a saving of energy and material consumption. Briefly, it is hoped that applications of industrial ecology within tourism might reduce negative environmental impacts from tourism and move tourism toward sustainable development.

References


