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Benchmarking of energy and utility infrastructures in industrial parks

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ABSTRACT

Based on technological progress in conjunction with globalisation, the role of industrial sites has been changing and a cost competitive infrastructure is decisive for a company's long-term success. This article will introduce an innovative approach to benchmark maintenance and electric energy costs to produce and distribute electric energy, steam, industrial and drinking water and compressed air by an empirical examination. In this study, a benchmarking evaluation within 9 chemical parks and chemical related industrial parks was performed. In total, 23 key performance indicators in the area of maintenance and electric energy costs of production and distribution were defined and calculated based on data collected from the participants. To compare the different infrastructures, the most important key performance indicators were adjusted by correction factors. Thus, the correction factors, which have to be very specifically defined for each area, increase the acceptance and applicability of the benchmarking methodology. In consequence, the benchmarking, using correction factors, enabled the comparison of different infrastructures and a justified discussion based on comparable and comprehensible figures. Here, the benchmarking results showed large differences in performance levels, indicating that there are still significant cost saving potentials in some industrial parks. In practice, this new approach provides a robust guideline for practitioners in analysing and advancing the competitiveness of infrastructures on a solid theoretical foundation and also supplies a valuable contribution to policymakers and academics.

1. Introduction

Starting in the United States, industrial parks have been used since the 1950s to foster economic development and to support the change of industry structures (Chen and Huang, 2004; Griefen, 1970; Reisdorph, 1991). In Europe, especially during the last 20 years, the shifting of new investments to locations outside of Europe led to a dissatisfying degree of utilisation of industrial sites and the increasing trend towards industrial parks. Together with the ongoing restructuring of the chemical industry (Jerrentrup, 2009), this trend is still expected to continue as industrial companies increasingly pull out as owners of industrial sites.

The chemical industry in Germany is a good example for this trend. After transforming traditional chemical sites into industrial parks, the whole German industrial park landscape has been, for many years, in a phase of restructuring and consolidation (Festel, 2007). The issues to realise cost saving potentials are increasing focus on core activities, including the sale of non-core areas, and the increase in efficiency through further improvement of organisational structures and business processes (Festel, 2008; Sakr et al., 2011; Tian et al., 2012). This is necessary as the decisive factor for the long-term success of industrial parks is a competitive cost level (Badri et al., 1995; Festel, 2009; Festel and Würmseher, 2013) based on the increased and more complex demands of globally active chemical companies (Behrendt, 2013).

Benchmarking is a useful instrument to identify the critical success factors that set the most successful companies apart from their competitors (Cooper and Kleinschmidt, 1995). As the costs for energy and utility infrastructures are covered by the companies located in industrial parks, benchmarking and best practice initiatives in this area to identify and realise cost saving potentials are crucial for the competitiveness of industrial parks and the producing companies at these locations. Between 2006 and 2007, a benchmarking study took place with nine chemical parks and chemical related industrial parks in Germany. As there are few chemical industry specific aspects in this study, only the term 'industrial parks' is used here. The participants P1 to P9 covered a broad spectrum of size and organisational structures (Fig. 1).

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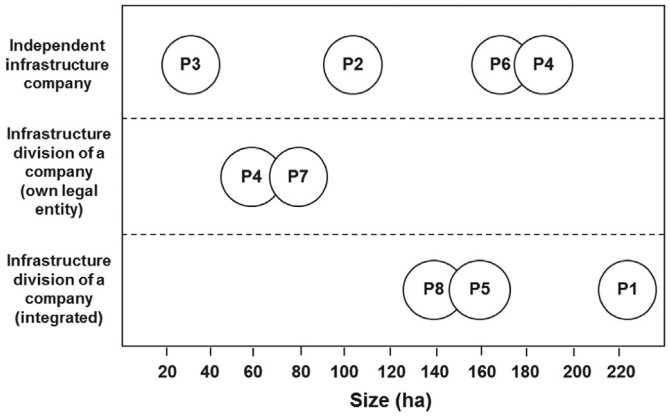

Fig. 1. Participants P1 to P9 of the benchmarking.

The size of the industrial parks was between 30 and 230 ha (ha). The organisational structures ranged from an infrastructure division, still integrated in the parent company, over an infrastructure division of a company as own legal entity to an independent infrastructure company.

Whereas benchmarking of energy consumption is well described in literature (Chung, 2011; Lee and Lee, 2009; Wong et al., 2009; Wu et al., 2010), academic literature on benchmarking of energy and utility infrastructures in industrial parks is primarily associated with eco-industrial parks and sustainability considerations (Elabras Veiga and Magrini, 2009; Gibbs and Deutz, 2005; Lazarus et al., 1999; Maes et al., 2011; Oh et al., 2005; Phylipsen et al., 2002; Tian et al., 2012; Worrell et al., 2009; Worrell and Biermans, 2005; Worrell et al., 2003, 2002). In contrast to these studies, which mainly focus on social or environmental aspects, the research presented in this article focuses on the economic dimension of energy and utility infrastructures in industrial parks and addresses the following research questions.

RQ 1: How can energy and utility infrastructures in industrial parks with different history and complexity be compared through benchmarking?

RQ 2: Is it possible to identify concrete cost saving potentials based on such a benchmarking and how can they be quantified?

Based on a benchmarking study with nine chemical parks and chemical related industrial parks in Germany this article describes an approach to benchmark maintenance and electric energy costs in industrial parks. After presenting the theoretical background in Section 2, the methodology part in Section 3 shows the scope and approach of the benchmarking. The subsequent discussion of the results in Section 4 gives the basis for the conclusions and recommendations in Section 5.

2. Theoretical background

This section starts with the definition and trends related to industrial parks followed by a discussion on benchmarking, including its drawbacks and its relationship to performance measurement.

2.1. Trends related to industrial parks

An industrial park is defined as “a large tract of land, sub-divided and developed for the use of several firms simultaneously, distinguished by its shareable infrastructure and close proximity of firms” (Peddle, 1990). Due to the generality of this definition, there are various types and synonyms of industrial parks, which include industrial districts, industrial processing zones, industrial clusters or industrial estates (Côté and Cohen-Rosenthal, 1998). Typically there is a private or public developer who provides the money for landscaping, infrastructure, and often for the basic physical plan (Peddle, 1993). This developer recoups the related investment through above-average rental or purchase prices charged to locating firms or through positive externalities of firm location (Campbell, 1958).

Due to the generally increasing awareness of ecological matters since the early 1990s, policy makers have been more and more focusing on a new form of industrial parks, the eco-industrial parks. This altered form of industrial parks has been thoroughly investigated by various authors (Chew et al., 2009; Côté and Cohen-Rosenthal, 1998; Frosch and Gallopoulos, 1989; Geng et al., 2007b; Heeres et al., 2004; Lambert and Boons, 2002; Lowe, 1997; Maes et al., 2011) and has occupied the whole attention on industrial parks in literature. An eco-industrial park is a community of manufacturing and service companies seeking enhanced environmental and economic performance through collaboration in managing environmental and resources issues. Besides output quality, worker health and public image, there is a coordinated cost management of energy, water and materials in order to achieve an improved operating efficiency by working together. Through this cooperation, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would have realised, if it had optimised its individual interests (Côté and Hall, 1995; Lowe et al., 1996).

This shift towards eco-industrial parks is surrounded by the rising attention to environmental considerations and generally the trend to greater importance of the social dimension of sustainable development. In consequence, recent research papers (Chiu and Geng, 2004; Gibbs and Deutz, 2005; Jung et al., 2013; Sagar and Frosch, 1997) increasingly focus on sustainable development as an integrated concept that combines economic growth, the social pillar and environmental protection, rather than an individual focus on one of those topics.

With regard to energy costs, the corporations clustered in the community can benefit from various advantages. Firstly, by a reduction of capital and operational expenditures, mainly due to reduced installation, maintenance and energy costs. Reduced installation costs are due to economies of scale, like higher production efficiency of large scale installations (therefore lower capacity required), accessibility to more efficient techniques or outsourcing of energy installation investments. Reduced maintenance costs are also caused by economies of scale, increased attainability of professional services or lower idle time losses through better maintenance. The reduction of energy costs can be achieved by lower energy prices from bundling energy demand (higher volume, more even energy consumption and production load curve), improved attainability of renewable energy use or the exchange of useful energy losses (Maes et al., 2011).

For comparing cost efficiency related to energy and utility infrastructures across different industrial parks, their size has to be taken into account in order to obtain meaningful results that are useful to a broad range of stakeholders, such as policy makers, industrial park operators and companies that are either already hosted in an industrial park or are looking for a potential location. Especially for the latter group, energy and utility costs may have a decisive impact on the decision about future locations and a justified as well as practical approach for comparing these costs will most likely receive their attention and acceptance. The companies’ decisions of where to locate have a significant influence on the regional economy and various authors (Festel, 2009; Qiu et al., 2010; Sun, 2011; Tian et al., 2012) point to the need to monitor specific costs in industrial parks. However, there are relatively few