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Measuring eco-efficiency in the Finnish forest industry using public data

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ABSTRACT

The aim of this paper is to discuss the measurement of eco-efficiency in the Finnish forest industry from three perspectives. First, the paper introduces a way to measure eco-efficiency in the Finnish forest industry. Second, the paper evaluates the suitability of public data for calculating eco-efficiency in the Finnish forest industry. Third, the calculations of selected eco-efficiencies are presented. The main method used in this research is the Delphi panel, and eco-efficiency indicators are based on the experts' rating. The environmental and economic performance information of the three biggest Finnish forest industry companies are used here as examples. According to the experts of the Delphi panel, the economic performance of the eco-efficiency should be measured using the 'value added' indicator. In environmental performance, they preferred the environmental impact or emissions groups. Based on public data, the value added data can only be calculated at the company level, although the environmental impact and emissions groups could be presented in detail as site-level figures. Eco-efficiencies can be calculated only with selected environmental aspects and for a limited time frame. The eco-efficiency calculations show varying trends for the three companies: improvements, declines and fluctuations in eco-efficiencies. The current research raises questions regarding the usability of public data as a source of research material, suitability of the indicators suggested for decision making of the forest industry, the need for more detailed data to study the development of the eco-efficiency of the Finnish forest industry and the need to compare the eco-efficiency performance of the Finnish forest industry with that of its international counterparts.

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1. Introduction

1.1. The concept of eco-efficiency

The concept of eco-efficiency combines the economic and environmental performance of a specific system. However, a commonly agreed definition of eco-efficiency does not exist (e.g. Braungart et al., 2007; Müller and Sturm, 2001; Schaltegger and Burrit, 2000; Verfaillie and Bidwell, 2000). Examples of the typical eco-efficiency definitions are provided in Table 1. The lack of a single definition can be explained by the various application levels of the concept (Huppel and Ishikawa, 2005). In the business context, eco-efficiency can be applied at the product, service, production, company or corporate level (Hoffrén, 2001; Schaltegger and Burrit, 2000; Verfaillie and Bidwell, 2000). Outside the business context, eco-efficiency has been used at regional, national and

global levels (Hoffrén, 2001; Schaltegger and Burrit, 2000; Verfaillie and Bidwell, 2000).

As mentioned, an exact definition does not exist, but the literature definitions can, for example, be divided into five types, as is done by Koskela and Vehmas (2012). Their first type of definitions relate to the statement of 'more from less'. In these definitions, the idea is to produce more physical output from fewer natural resources. In the second and third types of definitions, eco-efficiency is considered to be the ratio between economic output and environmental output. In the second, the focus is on productivity: producing more value added with less environmental impact. The third definition focuses on intensity: decreasing the environmental intensity of the economic performance. The fourth type of definition describes eco-efficiency as a management strategy. The fifth type is an adjustment to the management strategy definition by giving exact guidance on how to improve eco-efficiency in a company. The variations in the definitions of these five types are presented in more detail in Koskela and Vehmas (2012).

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Table 1
Examples of the definitions of eco-efficiency.

Reference	Definition of eco-efficiency
DeSimone and Popoff (2000)	'The first word of the concept encompasses both ecological and economic resources—the second says we have to make optimal use of both'. 'Eco-efficiency focuses as well on creating additional value by better meeting customer's needs while maintaining or reducing environmental impacts'.
Madden et al. (2005)	'Eco-efficiency is a management philosophy that encourages business to search for environmental improvements that yield parallel economic benefits. It focuses on business opportunities and allows companies to become more environmentally responsible and more profitable'. 'As defined by the World Business Council for Sustainable Development (WBCSD), "eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the Earth's estimated carrying capacity". In short, it is concerned with creating more value with less impact'.
OECD (1998)	'Eco-efficiency is the efficiency with which ecological resources are used to meet human needs'.
Schaltegger and Sturm (1990)	ecological efficiency = $\frac{\text{value added}}{\text{environmental impact added}}$
Schmidheiny (1992)	'... "environmental efficiency" – the ratio of resource inputs and waste outputs to final product'.
Sorvari et al. (2009)	'The generic definition for eco-efficient activities is: creating more value with fewer resources and less negative impact'.

1.2. The Finnish forest industry

The reasons for selecting the Finnish forest industry as an example for measuring eco-efficiency will be discussed from four perspectives.

First, the Finnish forest industry is a significant player in the global forest industry. In Europe, the Finnish forest industry was the second largest producer (after Sweden) of pulp in 2011 (CEPI, 2013). Regarding paper and board production, the Finnish forest industry was the third largest (after Germany and Sweden) in 2011 in Europe (CEPI, 2013). In 2011, the Finnish forest industry was sixth largest producer of both paper and board and pulp globally (Finnish Forest Industries Federation, 2013a). In addition, the Finnish forest industry is among the largest global exporters of forest industry products (Finnish Forest Industries Federation, 2006). In 2005, Finnish production amounted to 10% of the global forest industry exports (Statistics Finland, 2006). At the same time, the Finnish forest industry exported over 80% of its paper and board production (Statistics Finland, 2006). About 90% of Finnish forest industry sales come from outside Finland, especially from Europe, and about 60% of the paper production capacity is located outside Finland (Finnish Forest Industries Federation, 2006). This paper focuses on the three biggest Finnish forest industry companies, namely UPM-Kymmene, Stora Enso and Metsä Board (subsidiary of the Metsä Group). In Europe in 2012, Stora Enso was the largest forest industry company by sales, UPM-Kymmene the second and Metsä Group the sixth (Finnish Forest Industries Federation, 2013a). On a global scale, Stora Enso and UPM-Kymmene were the fifth and the sixth largest forest industry company by sales. Metsä Group is not among the ten largest companies (Finnish Forest Industries Federation, 2013a).

Second, the Finnish forest industry (like the whole forest industry) belongs to the heavy industries that have an environmental impact. There is considerable use of raw materials (mainly wood or wood-based products), water and energy (mainly wood-based but fossil fuels are used as well); thus, they produce various types of

emissions (emissions to air and water and solid waste). The environmental impact of the whole forest industry and of the different processes inside forest industry has been widely studied. Based on life cycle assessments (Berg and Lindholm, 2005; Dias et al., 2007; González-García et al., 2009; Jawjit et al., 2006),² the processes of the forest industry chains that contribute the most to environmental problems are chemical production, energy production and pulp/paper production. The most significant environmental pressures of the pulp/paper industry are the emissions to water, odours and the amount of solid waste (Gynther et al., 1999). In the forest industry, the main environmental impact comes from the consumption of raw materials, emissions to air, water and soil and effects on ecosystems caused by the harvesting of trees (Gabel et al., 1996).

Third, the Finnish forest industry has succeeded in improving its environmental performance over the years. The amount of BOD, AOX, phosphorus, particles, CO₂ and SO₂ emitted into the environment has decreased since the 1990s, although the amount of production has increased during the same time frame (Finnish Forest Industries Federation, 2009b; Statistics Finland, 2006). Only the level of NO_x has more or less followed the level of production (Finnish Forest Industries Federation, 2009b; Gynther et al., 1999; Statistics Finland, 2006).

Fourth, the Finnish forest industry has made its environmental figures publically available. There are multiple sources for the data. First, the companies themselves publish their environmental performance in their annual environmental reports. Second, their lobbying organisation, the Finnish Forest Industries Federation, publishes an annual report of the environmental performance of its member organisations. Third, there is an environmental permit regulation stating that these companies have to report their environmental performance to the environmental permit authority in Finland. All of these three sources are publically available. The content of these sources is discussed further in Section 3.2 Public data of the Finnish forest industry.

1.3. The aim and structure of the paper

The aim of this paper is to discuss the measurement of eco-efficiency in the Finnish forest industry. This aim is approached from three perspectives. First, the paper introduces a way to measure eco-efficiency in the Finnish forest industry. The eco-efficiency indicators are based on the rating from the expert Delphi panel. Second, the paper also evaluates the suitability of public data for calculating eco-efficiency in the Finnish forest industry. Third, the calculations of selected eco-efficiencies are presented. The three biggest Finnish forest industry companies (UPM-Kymmene, Stora Enso and Metsä Board) are used as examples.

The main method used in this research is the Delphi method. It is a method typically used in futures research, which aims to gather expert opinions or judgements about a subject matter's future possibilities, the likelihood of realisation and desirability (Bell, 2000; Mitroff and Turoff, 2002). A characteristic of the method is that the expert opinions are gathered by a structured group communication process (Linstone and Turoff, 2002). A more detailed description of the method and its application in the current research is provided in Chapter 3.1 Delphi method.

This paper is structured as follows: the next chapter goes into detail about the literature concerning the measurement of eco-

² Berg and Lindholm (2005) applied life cycle assessment in the forestry sector (from seedling production to secondary haulage), Dias et al. (2007) in paper production (from forestry to final disposal), González-García et al. (2009) in pulp production (from forestry to pulp mill) and Jawjit et al. (2006) in pulp production (from forestry to pulp mill).

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