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Ecological Performance as a New Metric to Measure Green Supply Chain Practices

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INTRODUCTION

Sustainable development has become a focus nowadays by governments, companies, communities, and even individuals. Manufacturing industry is the first to receive the brunt of criticism as manufacturing activities are assumed to be the prime culprit in creating environmental issues (Gunasekaran & Spalanzani, 2012). Massive consumption of natural resources and energy speed up the resources depletion rate which could scarify the needs of future generation for today's economic developments. Waste generation from manufacturing activities could create negative impacts like various pollutions to environment which subsequently hinder the operation of ecosystems (Cordoba & Veshagh, 2013).

Manufacturing companies are moving towards green oriented approaches in mitigating environmental issues. Green supply chain management is one of the approaches to address the relationships between supply chain management and natural resources management (Simao et al., 2016). According to Srivastava (2005), he defined green supply chain management as integration of environment thinking into supply chain management. Green supply chain initiatives included product design, materials sourcing and selection, manufacturing processes, logistics and distributions and product end of life management. Hawken et al. (1999) predicted a new industrial revolution that will be based on efficient use of resources. Today, the prediction has come true as eco-efficiency based strategy is now widely adopted by business organizations, especially manufacturing industry.

Manufacturing companies need a comprehensive evaluation system to measure the outcomes of the green supply chain activities that implemented. Anbumozhi and Kanda (2005) found that most of the developing countries remained to be the traditional command-and-control or end of pipe solutions which is very passive approach to reduce negative environmental impacts after they are created. This is because business benefit is the first priority to be considered in adoption of green supply chain practices. Balance between environment and economic is important to a company survival.

BACKGROUND

World Business Council for Sustainable Development (2000) defined eco-efficiency as 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 Earth's estimated carrying capacity. In short, eco-efficiency means creating more value with less impact. It is a concept that combines both economic and environment management. Managers will be motivated to engage in environmental management if the green supply chain initiatives can achieve both environment and economics performance at the same time.

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Current environment performance focuses more on environment impact intensity and resource use intensity by the firms. Although there is positive linkage between environment performance and economics performance, however it varies between firms. Ecological performance could bring more solid outcome measurement of green supply chain initiatives at market level (Boons & Wagner, 2009). According to Hart (1995), a company can build competitive advantages via natural environment management. Besides being cost effective, integration of natural system into business core value can help a company to have continuous improvement in aspects like quality and flexibility which can preempt competitors and appears as market leader in the manufacturing industry.

Therefore, the scope of performance measurement should be extended to wider indicators other than monetary facors. Besides cost reduction, Eltayeb, Zailani, & Ramayah (2011) suggested operational performance can be investigated from the perspective of quality, flexibility and delivery. In business context, organization has to be responsive to customer requirement in cost reduction, flexibility and quality product. Nowadays, supply chain responsiveness is not limited to business needs but environment needs as well. Supply chain responsiveness has to be designed with green concept incorporated which efficient to both economic and environment. The benefits brought by green supply chain initiatives are not constraint to the focal company manufacturing activities. Instead, it can be extended into wider scope so that more and more parties can enjoy the benefits.

An exploration in ecological performance should be carried out so that a more holistic performance measurement is developed to assist managers in decision making of adoption of green supply chain initiatives. This study is aimed to discuss the concept of ecological performance which extended from environmental performance.

ENVIRONMENT PERFORMANCE

Commonly, manufacturing companies measure environment performance in term of environment impact intensity that caused by human activities and resource use intensity (Bran et al., 2011). Environmental impact intensity covers emissions to water intensities, emissions to air intensities and GHG emissions intensities. While resource use intensity covers water intensity, energy intensity and materials intensity in a process. Table 1 shows the indicators used to measure environment performance in monetary form by various sectors.

Table 1. Indicators of environment performance in monetary measurement (Department for Environment, Food and Rural Affairs of UK, 2006)

Indicators	Resource-Use Intensity	Environmental Impact Intensity
Economy-wide	Water intensity (m^3/GDP) Energy intensity (J/GDP) Land use intensity (km^2/GDP) Materials intensity (DMI/GDP)	Emission to water intensities (t/GDP) Emission to air intensities (t/GDP) GHG emissions intensities (t/GDP)
Manufacturing	Water intensity (m^3/GDP) Energy intensity (J/GDP) Materials intensity (DMI/GDP)	CO_2 intensity (t/GDP) BOD intensity (t/GDP) Solid waste intensity (t/GDP)
Industry	Water intensity (m^3/GDP) Energy intensity (J/GDP) Materials intensity (DMI/GDP)	CO_2 intensity (t/GDP) Solid waste intensity (t/GDP)
Agriculture	Water intensity (m^3/GDP) Energy intensity (J/GDP) Land use intensity (km^2/GDP) Materials intensity (DMI/GDP)	CO_2 intensity (t/GDP) CH_4 intensity (t/GDP)