An ANP-Based Model for an Effective Green Supply Chain Management

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ABSTRACT

Green Supply Chain Management (GSCM) has becoming an imperative issue for several supply chains (SCs) due to environmental burdens defined by international legislation and to increasing costs of such a resource. The present paper proposes a decision support system aiming to evaluate more effective GSCM strategies. Thus, environmental performance of the whole supply chain, and consequently of each supplier involved, must be compared in a standardized and quantitative way. Thus, the proposed approach integrates index methods for Environmental Performance Evaluation (EPE) in developing a multi-criteria model based on the Analytic Network Process (ANP) technique. The integration overcomes criticalities of the two models. The approach has been validated in a real case study concerning the glass windscreen production supply chain.

Keywords: Analytic Network Process (ANP), Decision Support System, Environmental Performance Evaluation, Green Supply Chain Management (GSCM), International Legislation

INTRODUCTION

Environmental sustainability analysis of a product usually represents a complex issue essentially due to a lack of common shared approach. Currently, increasing regulatory and market pressures together with strong internal drivers are forcing companies towards the application of green supply chain management (GSCM) practices; on the other hand, standardized guidelines are not effectively widespread as usually many leading companies have internally developed eco-efficiency indicators for their own processes not for their supply chain (Gerbens-Leenes et al., 2003). The present paper proposes a multi-criteria decision support system for pointing out priority areas of interventions for GSCM where Supply Chain (SC) structure is mainly coordinated by a focal company. The approach is based on the integration of Environmental Performance Evaluation (EPE) with a multi-criteria tool based on the well known Analytic Network Process (ANP) model. Currently, index methods are widely applied at single firm level for performance analysis; by a SC point of view, they could not provide

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actual information about interrelationships which characterize the environmental sustainability analysis of the whole SC. Furthermore, the ANP technique could support evaluation of interdependencies among SC levels; otherwise, multi-criteria approaches are characterized by a high computational effort (Sarkis, 2003) as the model development phase is usually significant. Thus, the aim of the proposed approach is to develop an ANP model based on EPE system to identify significant factors which could heavily affect green performance of a supply chain. Consequently, the model could supply effective information about critical factors/areas in the whole supply chain in order to reduce environmental impact. The paper is organized as follows: in the section 2, current trends in green supply chain management have been analyzed aiming to assess main issues for developing effective GSCM tools in such a context. The proposed approach is fully described in section 3; next, an application concerning a specific case study regarding glass windscreen production supply chain has been proposed for validating the approach in a real case.

CURRENT TRENDS OF GREEN SUPPLY CHAIN MANAGEMENT APPLICATIONS

Currently, strategies for Green Supply Chain Management (GSCM) are becoming widespread in several industrial contexts as environmental sustainability of a product represents a key factor for competitive advantage. These issues are forcing the development of different approaches for evaluating the environmental sustainability level of a supply chain: according to a typical supply chain structure, green procurement, manufacturing and distribution, and finally, reverse logistics could be effective fields of interventions. By comparing with a single firm, the complexity increases in environmental sustainability analysis of a supply chain as several different companies have to coordinate their efforts in order to improve their global environmental performance (Sonesson & Berlin, 2003; Pineda-Henson & Culaba, 2004). Thus, two main types of approaches could be outlined:

- **Top-down models**: which are mainly based on a global level analysis. A reference model is the well known Life Cycle Analysis (LCA) approach which allows to measure environmental sustainability of a supply chain from a system perspective (“i.e. from cradle to grave”). According to this approach, process-based strategies for GSCM are defined as “greening the supply chain processes” (Vachon & Klassen, 2008): the aim is to link performance regarding all processes and services inside and outside factory gates.

- **Bottom-up models**: which are focusing on evaluating the contribution of each individual company on the whole environmental performance of a supply chain (Gerbens-Leenes et al., 2003). Climate change, related fossil energy use, ISO 14000 guidelines refer to this category. Thus, product-based strategies - defined as “supply chain management for sustainable products” (Koplin, 2007; Seuring & Muller, 2008) – aim to determine specific requirements for each supplier in order to guarantee product environmental compatibility.

According to these issues, a brief literature review has been carried out in order to point out current applications of GSCM models. The review starts from year 2000 to 2009; 30 is the total number of paper analyzed. Firstly, recent review based on scientific literature analyses have been recently proposed in (Tsoulfas & Pappis, 2006; Seuring & Muller, 2008, Halldorsson et al., 2009); on the other hand, survey analyses are proposed in (Walker et al., 2008; Nawrocka et al., 2009). The first paper proposed an analysis of drivers and barriers to GSCM according to top-down approaches; the latter analyzed benefits and criticalities of a bottom-up approach, i.e. the standard ISO 14000. Then, the literature review has been carried out by evaluating another critical factor...
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www.igi-global.com/article/investigating-relationships-between-supply-chain-capabilities-competitive-advantage-and-business-performance/165509?camid=4v1a