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A business strategy selection of green supply chain management via an analytic network process☆

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ABSTRACT

This study designates green supply chain management (GSCM) strategies to effectively direct business functions and activities in the electronics industry. Enterprises conduct environmental scanning to understand the external environment and internal functions; a successful strategy identifies unique firm-owned resources and transforms them into capabilities. This study proposes a network to clarify managerial levels and firm-related content. It derives four business functions from product lifecycle management: design, purchasing, manufacturing, and marketing and service—and associates their related activities with "greenness". These functions and activities are a network's clusters and elements in an analytic network process (ANP) model with dependent relations. A detailed procedure solves complex GSCM strategy-selection problems and evaluates the most important activity in each business function. A case study takes a leading Taiwanese electronics company to identify the proposed procedure's stability.

1. Introduction

Environmental deterioration and global warming have prompted public concern over sustainability and environmental issues. In response to increased worldwide attention on the overall conditions of natural resources and the environment, several countries have adopted regulations such as the Restriction of Hazardous Substance in Electrical and Electronic Equipment (RoHS), Waste Electrical Electronic Equipment (WEEE), Eco-design Requirement for Energy Using Product (EuP), etc. Such legislation forces manufacturers to decrease pollution during the whole production process [1,2]. It is especially applicable for the electronics industry, with its rapid technology development, consumers' desire for the newest products, shorter product life-cycles, and indirect e-waste. Since hazardous materials are the greatest concern in electronics products, this study develops a green strategic selection guideline to aid company decisions.

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Many manufacturers have adjusted their manufacturing philosophies and introduced environmental programs into their organizations. Through social and environmental responsibility (SER), some firms proactively recognize the urgency of environmental protection and have integrated environmental goals into their corporate strategies. Xerox and IBM have set up environmental criteria to manage end-of-life (EOL) products or to appraise their value. Sony has required all related suppliers to follow Green Partner Activities since 2001, and has improved its own green management efforts [3].

With rapid international business development, firms with relatively limited resources must outsource some business functions or operations, or purchase raw materials or components/sub-components from other suppliers to establish an interrelated supply-chain network. To advance their environmental performance, they must monitor their own operations and coordinate with other partners in their supply networks, including material suppliers, manufacturers, distributors, users, and so on. Supply-chain managers consider both traditional performance criteria and environmental criteria, or GSCM [3]. Taiwan's electronics manufacturing companies, such as Original Equipment Manufacturing (OEM) and Own Branding & Manufacturing (OBM), are essential players in the global supply chain and now proactively realize GSCM. An investigation of green businesses will be beneficial to them and the environment as well.

A literature review of GSCM yields studies linking green, environmental, or sustainable concepts to traditional supply-chain management, demonstrating how GSCM practices, definitions, and decision frameworks affect business operations [4–6]. Most studies emphasize reduction, re-manufacturing, recycling product design, process design, manufacturing practices, procurement, and some mixture of items across managerial levels. Integrating environmental concepts into these business functions ameliorates environmental pollution. However, a more elaborate and organized analysis allows efficient implementation of GSCM strategy.

Poole and Simon [7] suggested life-cycle analysis as a method of examining the overall environmental impact of a product. Kurk and Eagna [8] also extracted environmental attributes from each phase of a product's lifecycle, including raw-material extraction, product manufacturing, packaging and transport, use and service, and final disposal.

Few studies until now have emphasized developing GSCM strategies from an overall organizational perspective. Handfield et al. [9] observed the increasing importance of supply-chain strategy as management increasingly adopts environmental practices. Effectively achieving corporate green goals means linking an environmental corporate strategy with every business functional strategy, thus eliminating obstacles to environmental integration. Decision-makers should appropriately modify the contents and aims of environmental practices to match changes in business development. Many companies have just begun exploring environmental concerns and implemented environmentally-friendly activities, so they have not yet identified many environmentally-related factors. Rethinking the relationships between each factor of environmental practices is therefore necessary.

Key ingredients for a successful corporate strategy depend on whether resources or capabilities are rare, durable, or difficult to imitate. This study extends this concept, utilizing the product lifecycle management (PLM) viewpoint to choose business functions related to this process (design, purchasing, manufacturing, and marketing and service), and constructing a fundamental decision-making framework for "green" practices.

Past studies use MCDM approaches to analyze environmental problems [10,11]. This study chooses a single network of analytic network process (ANP) [12] to address the problem for several reasons. First, AHP and ANP are appropriate analytical tools for addressing locations, programs or strategy-selection problems, such as choosing an ideal location, program, or strategies [13–16]. Second, ANP permits a suitable analytical model to evaluate suppliers and minimize potential risks [17–19]. Third, ANP's more structured network not only helps decision makers understand the problem more clearly [20,21] but also saves more time than normal discussion without an organized process. It focuses the dependent and feedback relations among factors in the network, so that the dominance of influence among stakeholders, alternatives, criteria, and other specific elements is organized to mimic the actual decision-making environment. Finally, a single network maintains group focus on internal relationships and influences between core influential factors (main business functions).

Section 2 discusses key business functions, the factors of each function, and alternatives. Section 3 proposes a systematic ANP procedure and Section 4 demonstrates a case study with sensitivity analysis. Finally, the study draws conclusions and indicates directions for future research.

2. Literature review

To establish an adequate analytical network, this paper reviews green management perspectives, clarifies their definitions, and surveys the influential factors of each function based on the stages of PLM: green design, green purchasing, green manufacturing, and green marketing and service. Then, it examines GSCM strategy.

2.1. Green management perspective

Van Hoek [22] believed a business should face up to environmental issues and create competitive advantages through green initiatives. He used three approaches in green management [23]: reactive, proactive, and value-seeking. Noci [24] initially involved the green perspective in the supplier-selection process and divided corporate green strategies into reactive and proactive types. The former requests that suppliers only defer to regulators, while the latter expects suppliers to assist