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A quantitative analysis of relationships between product types and supply chain strategies

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Abstract

Supply chain management has been given so much attention that various technologies and concepts have been applied to improving and optimising supply chain performance. However, failures in supply chain management are still not uncommon in today's industries. One important reason is the failure to sort different products into categories related to appropriate supply chain management strategies. Qualitative analyses on the characteristics of products and their impacts on supply chain performance have been reported in the literature. Whereas quantitative analysis of matching products to supply chain strategies has so far not been sufficient to assist decision-making significantly in supply chain management. This paper is focused on a quantitative analysis to match types of products to supply chains based on a mathematical model. Using a multiple objective optimisation model, a sensitivity analysis has been conducted to detect variance of performance in relation to three typical supply chain strategies (manufacturing to order, manufacturing from stocks and manufacturing to stocks), and based on different product characteristics (value-adding and demand uncertainty). The model is particularly designed for evaluating performance of supply chain strategies with the product characteristics mentioned above. The analytic results disclosed some quantitative relationships between the performance of the supply chain strategies and product attributes, which could provide assistance to decision making on operational and strategic supply chain management.

Keywords: Manufacturing strategy; Product attributes; Supply chain management

1. Introduction

Despite the attention given to new technologies and to concepts for improving supply chain (SC) efficiency, 'the performance of many SC has never been worse' [1]. In Fisher's [1] research, the reason for this phenomenon is attributed to a mismatch between product types and SC strategies. In the research, a number of cases were analysed to indicate reasons for success and failure in supply chain management (SCM). As a result of the research, Fisher proposed a conceptual model for matching product types to SCM strategies as illustrated in Fig. 1. As seen in the conceptual mode, products are classified into two categories, functional products (with small demand variance and low profit margin) and innovative products (with uncertain demand, high variety, and high profit). Then, SC

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	Functional Products	Innovative Products
Efficient Supply Chain	*Match*	*Mismatch*
Responsive Supply Chain	*Mismatch*	*Match*

Fig. 1. Fisher's conceptual model on matching SC strategy to products [1].

strategies are classified into a physically efficient process to 'supply predictable demand efficiently at the lowest possible cost', and a market-responsive process to provide quickly response to unpredictable demands. Fisher's conclusion provides a significant framework for establishing suitable SCM strategies under particular operational environment.

In practical supply chain operations, companies are facing SCM problems which concern more concrete production planning and quantitative operational decisions than merely qualitative strategies and product type identifications. Therefore, more explicit quantitative criteria and tools for SC strategy designs would provide further benefits to SCM. The research in this paper is focused on investigating the impacts of such operational parameters as value adding capacity, demand uncertainty and material cost on the performance of manufacturing strategies by quantitatively modelling the operational process of companies in supply chains. The objective of the research is to explore the influence of significant operational parameters (which reflect influencing product attributes proposed by Fisher's research [1]) on SC efficiency based on different strategies. The research shows the impact of the quantitative product characteristics on the operational performance of three manufacturing strategies (manufacturing to order, manufacturing from stocks and manufacturing to stocks) based on sensitivity analysis of a multiple objective optimisation model. The quantitative model can be a tentative decision support tool to optimise efficient or responsive SC strategies under particular operational environments.

2. Modelling manufacturing strategies

To model the decision process under different operational conditions, a multiple objective optimisation model was developed. The model was revised and derived from the authors' previous work [2] to adapt it to the particular problem in this research. Adapted from Fisher's classification [1] of SC processes (physically efficient process and market-responsive process), three commonly used strategies are employed in the model as alternative strategies for SCM: manufacturing to order (MTO), manufacturing from stocks (MFS) and manufacturing to stocks (MTS). The three SCM strategies represent three kinds of processes, respectively; a physically efficient process, a market responsive process, and a physically responsive process.

The model is focused on evaluating the manufacturing process under the three strategies so that the influence of production constraints on the performance of different SC strategies can be detected. The evaluation is conducted based on an optimised operational process which pursues high performance by trading off the contribution of each performance criterion (profitability, responsiveness and reliability). Time has been treated as a key factor in this model to measure SC efficiency, i.e., all decision variables are measured by time unit (e.g., inventory level is measured by a number of days of supply, so that cycle time can be linked to stocks) [4]. The costs of reducing production throughput time are also analysed as they influence profit margins when a strategy with excessive capacity is employed. The primary assumptions are listed in Table 1. Based on such assumptions, the strategies and different roles of key factors in the model are illustrated in Fig. 2. The model structure in mathematical format is depicted in Eq. (1). The definitions of parameters and variables in the model are listed in Table 2. The performance (PE) is measured by gaps between targets (customer requirements) and planned values. PE is a weighted sum of three