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Analyzing single and multiple customer order decoupling point positioning based on customer value: A multi-objective approach

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Abstract

First step for the implementation of MC is to determine the desired level of product variety offered to customers (or customization degree). The right decision on the position of Customer Order Decoupling Point (CODP) is critical to determine the level of customization. . In this model, we develop two objective bases on company's profit and customer values perceived and analyze impacts single-CODP and multiple-CODP on product variety with trade offing among two proposed objective under service time constraint. We validate the model through a case.

1. Introduction

With increasing demand for personalized products, mass customization (MC) strategy (satisfying the customer's individual need with the cost near mass production [1, 2]) has been more implemented in the recent years. The right implementation of MC depends on the determination of customization level. The level of customization is the provided individualization of mass-customized products offered to customers [3]. The ability of a company to make differentiated products with low cost and quick response time depends both on the position of customer order decoupling point (CODP) and on the position of production differentiation points (PDP).

Forecast-based activities are performed in upstream of the CODP and activities based on customer orders are performed in downstream of the CODP. Different manufacturing environments such as make-to-stock, make-to-order and assemble-to-order all relate to the different positions of the CODP [4]. In the real production process, many enterprises usually have more than one CODP depending on the product specifications or the type of client. For example, the Boeing Company has 3 CODPs [5]. Multiple-CODP systems have two or more distinct stock holding locations among the production and delivery processes from which raw materials or part-finished products can be taken, allocated to a customer, finished and delivered [6].

Satisfaction of customers is related to value perceived through variety products [7, 8]. Value measures the overall assessment of the utility of a product by customers. Daaboul et al. discussed different definitions for value [9]. Position of CODP influences on varieties offered to customers and thus value perceived by customers.

Variety builds a portfolio of products for each set of products (e.g. a set of products with three variants, a set of products with two variants and a set of products with only one variant). Each set of these products may have an optimum CODP. We can get two scenarios for determining CODP position:1) Selecting a CODP position for all sets of products; 2) Investigating possibility of selecting CODP position for each set of products thus multiple CODP for a given portfolio.

The aim of this paper is to evaluate of these two approaches in order to select CODP positions. To do it, we propose a multi-objective programming model based on customer value and company's benefit. Output of this model is both determining CODP position and determining products that can be manufactured.

The paper is organized as follows: section 2 reviews literature related to CODP position. Section 3 describes both the concept of value and $\varepsilon-$constraint method [10] to solve multi-objective model. Section 4 develops the model based on customer value and company's benefit. Section 5 solves the model for a case and compares the results for single-CODP and multiple-CODP production system. Section 6 represents conclusion and future research.

2. Literature

The researches on CODP often focus on theory and application. Blecker investigated the uncertainty resulting from moving of CODP [11] and Wikner made a study on application of CODP in logistics [12]. Ma studied impacts of CODP on stock, cost, lead time and customization [13] and Fan studied the logistics service model of CODP [14]. Huang et al. compared the cost change before and after the CODP [15]. These papers don't focus on how to find position of the CODP.

Concerning the researches on the position of CODP, Diwakar investigated the cost and income of postponement strategy by using queue theory to determine the best CODP position [16]. Lee analyzed CODP positions by considering the stock cost, processing cost and investment cost without discussing about lead time [17]. Aviv develops a model with uncertain demand distribution and different costs, not mentioning the constrain problem of productivity and lead time [18]. Wang recognized the factors affect the position of CODP and used analytical hierarchy process (AHP) to analysis the importance of the factors and to posit the CODP [19]. Ji et al. built up a model to position CODP with cost objective and lead time restriction [20]. Wu et al. proposed a model for the CODP position on profit and by using tandem queues [21]. Li proposed a cost optimization model to find location of CODP based on the queuing theory [22]. Qin and Geng proposed a basic model of production cost in postponement system based on various CODP [23]. Jian-qiang et al. proposed a multi-objective model consisting of product function, manufacturing cost and lead time, for positioning of CODP. The entropy technology and ideal point principle is given to derive the optimal solutions [24]. Sun et al. developed a mathematical model in order to find the multi-decoupling points in the supply network through MTO and MTS integration, with the objective of minimizing the overall cost subject to satisfying customer delivery time [25].

All papers discuss about one single-CODP for the whole portfolio but in mass customization production systems; there can be multiple CODPs (one per type of orders) because of multiple customers' individualized requirements. Determination of number and position of CODPs is an important step to recognize different varieties offered to customers.

Although customer satisfaction is recognized as main driver of MC, researches on the CODP position focused more on the cost point of view. Satisfaction of customers is related to value perceived from customized products. Number and position of CODPs influence on value, it has for instance a great impact on lead time.

The aim of this paper is to analyze the impacts of single-CODP and multiple-CODP with trade offing among two objectives (company's profit and customer perceived value) while considering service time constraint.

3. Background

In this section, we describe the concept of customer value and $\varepsilon-$constraint method to solve multi-objective programming problem. The $\varepsilon-$constraint method is used to propose a set of non-dominated solutions to decision makers.

3.1. Value

Value, is defined as the judgment carried by the user on the basis of his/her expectations and motivation. Value network has different beneficiary parties [26] such as the customer, suppliers, enterprise, stakeholders, etc. In this paper, we consider only the value for customers and the company (through its profit).

Customer value is influenced by several factors, such as the product quality, price, the services provided, the customization offer, and the delivery lead time. Daaboul et al. introduced several performance indicators to evaluate customer value [6]. In this paper, we use two of these indicators to build up a multi objective model to determine position of CODP and customization offer.

3.2. $\varepsilon-$constraint method

Optimum solutions of a multi-objective problem are found while identifying a set of non-dominated solutions within the feasible region [27]. In this approach, a solution cannot, in general, optimize all objectives. A set of non-dominated solutions can be obtained through the $\varepsilon-$constraint method that is described with a given maximization bi-objective problem as follows:

$$\underset{x \in S}{Max} \; z_1(x), z_2(x) \tag{1}$$

where z_1 and z_2 are objective functions, and S is feasible region in objective space. The following steps enable to obtain a set of non-dominated solutions:

Step1. Construct a payoff table by providing a systematic way for finding limits of the objectives:

1-a: Determine optimum value for each objective by solving the multi-objective problem as a linear programming problem when only one objective is considered at each time.

1-b: Determine ranges of objectives. Let x_1 and x_2 denote optimal solutions for the first and second objective, and then limits of each objective are determined:

$$Z_1(x_2) \le Z_1(x) \le Z_1^*(x_1) \text{ and } Z_2(x_1) \le Z_2(x) \le Z_2^*(x_2)$$