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Establishing customer order screening mechanisms under customization environment

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ABSTRACT

Under the customization production environment, it is necessary for enterprises to offer more varieties of products to cope with the demands of different customers. However, the variation in the customized product specification often leads to problems in the enterprise such as an improper design or an uncoordinated manufacturing procedure that causes a much higher or loss. Therefore, enterprises will be able to take profits under control more precisely if they can tell whether the customer's order is acceptable and estimate the new product cost.

To deal with this issue, the authors attempt to develop an evaluation and decision-making system for the customized orders. In this study, customer's orders are evaluated by a two-stage model. First, the Analytic Hierarchy Process (AHP) is used for the initial screening of orders. While some orders can be directly accepted or rejected, others may need a double check by the business sectors and customers. In the acceptable orders, the Case-Based Reasoning (CBR) is used to pick up the case most similar to the new product case for the evaluation of product cost and price setting.

At last, the PC product is used as an example to illustrate the proposed methodology. The building of an objective order screening system will help enterprises to make up proper strategies regarding the order selection.

1. Introduction

In the current few diverse product manufacturing environment, many enterprises have adopted the customization production strategy. The term customization indicates that enterprises offer different products or services for customers to select. In these enterprises, R&D departments are required to provide a more variety of products which not only cope with the individual customers' demands but also meet the cost and production requirements in the company. It is a characteristic of the few diverse manufacturing concepts (Pine, 1993).

In such a customization production environment, product configuration management is a key issue. A product configuration is composed of various materials and components whose constitutions and required quantities are described in the bill of material (BOM). In a product configuration study of computers, 30–85% are wrong and it often results in the abnormality in the following manufacturing process and a longer lead time (Fohn, Liau, Greef, Young, & O'Grady, 1995). In the past, varying ways of solutions have been proposed to solution this problem. Regarding the product configuration database, Hegge and Wortmann (1991) proposed the Generic BOM (GBOM) to solve the problem in product configuration management. They attempted to generate a Generic Product Structure to describe a product and when the manufacturing or production information gets beyond the range of GBOM, an Assembly Structure of product family is adopted. Olsen and Sætre (1998) claimed that the inflexibility of tables is the main reason why BOM cannot be transformed into the table structure. Because tables are unable to reach the requirement of BOM, they proposed syntax to cope with the variance and flexibility in product design. Furthermore, they consider it important to work out a BOM that can handle a great amount of information and variance in product configuration can be brought under control, a customer-oriented BOM mode. Jiao and Tseng (1999) considered that a single product information processing is not sufficient for the requirement in product differentiation. Instead, an integrated platform in the name of Product Family Structure (PFA) is needed. Such a PFA contains a basic products or modules, and new product differentiation can be generation by timely adjustment of PFA according to the market situation so as to meet the customers' demands. Simpson (2001) proposed another way to build differentiation in the design of product family in an enterprise by Goal Programming and statistical methods. To clarify the objectives and limitations under the

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customization environment, Akgunduz, Zetu, Banerjee, and Liang (2002) adopted a model similar to linear programming to build up the strategy. Moreover, Tseng, Chang, and Chang (2005) applied the theory of CBR for the construction of product configuration, in which the feature tree starts from the product function and each product configuration is stored in a single specific feature tree and product information is recorded in the nodes and branches. With the theory of CBR, product configurations in the library will be used for comparison. Jiao, Simpson, and Siddique (2007) and Fogliatto, da Silveira, and Borenstein (2012) made an overview regarding the studies on customization.

During the customized BOM procedure, enterprises need to efficiently identify customer's demands, adjust their product design, and deploy the production activity. However, the proliferation phenomenon of the configuration information that comes with the product exploitation procedure often causes a heavy burden to the enterprise. Accordingly, Croxton (2003) proposed an order fulfillment process (OFP) that emphasizes the whole aspects, a framework that contains strategies and operational layers. This is a problem enterprises have to face in the customization production environment. Alternatively, Pil and Holweg (2004) studied the relationship between product variety and order-fulfillment strategies, in which two strategies were make-to-forcast and build-to-order. Then, Tseng and Chen (2006) proposed the binary tree concept to build product configuration. The binary tree is a basic tree diagram data structure mainly for the storage of ranking data. It is an integrated structure particularly helpful in data storage, listing, retrieval, and processing. Overall, most of these studies focus on the management or tools for product configuration. On the other hand, Zhang, Lee, and Xu (2010) proposed an integrated order fulfillment process composed of four parts, including order processing, product configuration and process plan generation, production execution, and product delivery. During the OFP procedure, many communication and coordination jobs among different sectors in a company are involved. In many cases, human errors or carelessness may cause problems in the trial production stage. For example, if the regulation in the product design is too complicated to match the mass production requirement, it will result in an uneven manufacturing procedure, inferior quality, low productivity or high cost. Therefore, if we can solve the product configuration problem in the earlier stage of OFP, the burden the enterprise has to bear will be reduced. For this reason, the present study is focused upon the OFP problem in the customization environment.

Though some scholars had dealt with OFP problems in the past, for example, Gharehgozli, Rabbani, Zaerpour, and Razmi (2008), their studies were only related to production model such as Make to Order (MTO) or Make to Stock (MTS) but not suitable for the customization order because customization order frequently changes due to the difficulties in engineering or product specification modification. For the time being, rare literature has been seen regarding how to correctly evaluate orders and effectively make strategy for BOM. As far as OFP is concerned in the customization environment, how the business sector deals with orders is a key issue. Particularly, in most cases where the number of orders is the major criteria for the measurement of personnel performance, the blind acceptance of all orders is often not on the side of other divisions such as product development and production units. What's worse is that the insufficient communication between units in an enterprise often leads to an unworkable BOM or brings the design team into a difficult situation. It is, therefore, an urgent matter to build up a good management tool for such kind of problems. The profit control in the customization, as a matter of fact, should start from the contact of customer, and after the confirmation of the customer, an initial product configuration can be rapidly generated. After the information transmission to R&D department, sometimes a redesign and modification should be done for the accurate BOM, which can help guarantee the smooth manufacturing procedure. It is clear that the error rate of BOM will reduce if we can take advantage of the previous successful cases where modifications are made to cope with customized demands. More importantly, this will uplift the commonality of parts and reduce to total cost in an enterprise.

In this study, the authors attempt to develop a customer order evaluation methodology under the customization environment to help enterprises make correct strategies regarding customization order. The customization order screen mechanisms are primarily dealt in two stages:

1. At Stage 1, the strategy makers identifies the category of order at the contact of customers according to their experience and characteristics in the industry. Some orders can be directly accepted or rejected; others should be reconfirmed by the business sectors and customers in terms of the specification and price. At Stage 1, the Analytic Hierarchy Process (AHP) is adopted for the initial order screening.
2. At Stage 2, for the accepted order, a previous case most similar will be picked up through Case-Based Reasoning (CBR). With related BOM information, the evaluation of order will be conducted by the cost assessment to make sure that the accepted order is profitable, thus reducing the risk in the total OFP procedure.

In Section 2, the concepts of product feature and AHP are discussed for the initial screening of order at Stage 1. To implement the order screening at Stage 2, a two-level weight procedure is introduced in Section 3. Then, Section 4 describes the integrated algorithm. In Section 5, a practical computer parts example is illustrated. Finally, conclusions and suggestions are reached in Section 6.

2. Product features and initial screening of order

2.1. Product features

In this study, the product feature graph defined by product feature is used to describe the related configuration information related to BOM in the customization environment (Tseng et al. 2005). The so-called product feature represent the information property attribute such as the product form, function, quality characteristics, technical specification, and so on, which can serve as the reference for the product selection. The items of product feature should be decided by the decision makers in a company. The product features vary in industries and enterprises. In practice, the customer needs to specify the product features according to the product category and the environment. For the personnel in a company, the consistent language for the communication of product features will reduce the error rate result from misunderstanding. Furthermore, this helps the management of the product life cycle in an enterprise. For people out of the enterprise, the consistent product features can help make possible the effective communication with clients and suppliers through key information terms.

In this study, the description of the feature tree is adapted from that of Tseng et al. (2005) with the difference where the node description is changed to the description of attribute value. In this way, more information can be contained and it is closer to the description of BOM. As can be seen in Fig. 1, the example of computer parts (http://tw.asus.com/Desktop/Gaming/CG6191/), the parent–child hierarchical relationship in the tree structure can express the relations between nodes and their sub-nodes. In Fig. 1, the nodes represent parts/sub-assembly and *Ni* represents their part numbers. And the feature attributes are terms used to describe