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ABC inventory classification with multiple-criteria using weighted linear optimization

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Abstract

Inventory classification using ABC analysis is one of the most widely employed techniques in organizations. The need to consider multiple criteria for inventory classification has been stressed in the literature. A simple classification scheme is proposed in this paper using weighed linear optimization. The methodology is illustrated using an example.

Keywords: ABC Inventory classification; Multiple criteria; Weighted linear optimization

1. Introduction

Inventory classification using ABC analysis is one of the most widely employed techniques in organizations. This classification is based on the Pareto principle. ABC analysis is easy to use and simple to understand by an average materials manager. Normally, the items are classified based on the annual use value, which is the product of annual demand and average unit price. Class A items are relatively few in number but constitute a relatively large amount of annual use value, while class C items are relatively large in number but constitute a relatively small amount of annual use value. Items between the above two classes constitute class B, though some studies claim that there is no need to include this class in

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the analysis [1]. Class A items have to be controlled tightly and monitored closely. Textbooks such as Silver et al. [2] provide more details on inventory control policies for these classes of items. ABC analysis is successful only when the inventory being classified is fairly homogeneous and the main difference among the items is in its annual use value (computed from unit price and demand volume). In practice, an organization of even moderate size has to control thousands of inventory items and they need not be very homogeneous. As more and more customers demand a wide range of products, the need to increase the variety of inventory items is also increasing. Thus, it has been generally recognized that the traditional ABC analysis may not be able to provide a good classification of inventory items in practice [3–5].

There are many instances when other criteria, other than the annual use value, become important [3] in deciding the importance of an inventory item. This problem of multi-criteria inventory classification (MCIC) has been addressed by some studies in the literature. Some of the criteria considered in the literature include inventory cost, part criticality, lead time, commonality, obsolescence, substitutability, number of requests for the item in a year, scarcity, durability, substitutability, repairability, order size requirement, stockability, demand distribution, and stock-out penalty cost [1,3,5–8].

Complex computational tools are needed for multi-criteria ABC classification. Flores et al. [9] provide a matrix-based methodology. A joint criteria matrix is developed in the case of two criteria. However, the methodology is relatively difficult to use when more criteria have to be considered. Several multiple-criteria decision-making (MCDM) tools have also been employed for the purpose. Cohen and Ernst [10] and Ernst and Cohen [11] have used cluster analysis to group similar items. The analytic hierarchy process (AHP) [17] has been employed in many MCIC studies [9,12–14]. When AHP is used, the general idea is to derive a single scalar measure of importance of inventory items by subjectively rating the criteria and/or the inventory items [9,3]. The single most important issue associated with AHP-based studies is the subjectivity involved in the analysis. Heuristic approaches based on artificial intelligence, such as genetic algorithms [3] and artificial neural networks [5], have also been applied to address the MCIC problem. Clearly, these approaches are heuristics and need not provide optimal solutions at all environments. In this paper, we propose a simple weighted linear optimization model to address the MCIC problem.

2. Model development

Assume that there are N inventory items, and that the items have to be classified as A, B or C based on their performance in terms of J criteria. In particular, let the performance of mth inventory item in terms of each of the criteria be denoted as y_{mj}. Let us further assume that all the criteria are positively related to the importance level of the item—i.e., the larger the score of an item in terms of these criteria, the greater is the chance that the item be classified as an A-Class item. This assumption is made because most of the criteria used in inventory classification [1–3,5–8] are positively related. Even if there are inversely related criteria, reciprocals of the scores could be used to make them positive criteria.

In the proposed approach, a weighted additive function is used to aggregate the performance of an inventory item in terms of different criteria to a single score, called the optimal inventory score of an item. The weights are chosen using optimization subject to the constraints that the weighted sum, computed using the same set of weights, for all the items must be less than or equal to one. The model