Initial Shelf Space Considerations at New Grocery Stores: An Allocation Problem with Product Switching and Substitution

PEDRO M. REYES  
Baylor University, Hankamer School of Business, P. O. Box 98006, Waco, Texas 76798, USA  
pedro_reyes@baylor.edu

GREGORY V. FRAZIER  
Information Systems and Operations Management Department, College of Business Administration, The University of Texas at Arlington, Arlington, Texas 76019-0437, USA  
frazier@uta.edu

Abstract. Managing limited display areas is an increasingly challenging task in the grocery retail industry, especially given the current high levels of product proliferation. The decision of how to best allocate and manage shelf space is critical to grocery retail profitability. Moreover, this decision is escalated for initial shelf space considerations at new grocery stores. Without loss to generality, this paper presents a new approach to the shelf space allocation problem that could be applied to new grocery stores for determining their initial shelf space consideration by incorporating consumer behavior actions based on the consumer's decision process.

Keywords: shelf space allocation, grocery retailing, product proliferation, modelling

With the growing self-service retailing industry and the proliferation of new products, the management of scarce display areas continues to be an increasingly sensitive subject. The decision of shelf space allocation and management is critical to effective grocery retail operations management and is escalated issue for those new (and often independent) grocery stores. A well-managed shelf space not only improves customer service by reducing out-of-stock occurrences; it can also improve the return on inventory investment by increasing sales and profit margins (Yang, 2001; Yang and Chen, 1999). Ideally, the decision rules regarding shelf space allocation should consider the profit contribution of each product in the category against the opportunity costs for carrying the inventory (Cox, 1964, 1970). The theory within the context of self-service grocery retail stores is that the demand for a product is influenced by the quantity of display exposure, and it has been speculated that this structure of promotion is capable of shifting brand choices among consumers (Anderson, 1979; Urban, 2002).

In general, one of the primary concerns of grocery retail management involves determining the variety of brands to be stocked, and the allocation of scarce shelf space...
among these stocked brands so as to maximize the retail store’s profits. A subset of items from the entire category must be selected in order to maximize profits for the category, which is different from maximizing each product independently (Bawa, Landweher and Krishna, 1989; Judd and Vaught, 1988; McIntyre and Miller, 1999; Nielson, 1995).

Once the category assortment has been determined, the next step is the shelf space allocation. There are many approaches to the shelf space allocation problem. Among them are optimization models whose optimal decisions are obtained using some operational constraints with respect to the practical retail environment. The primary argument in the literature posits that the allocation decision is critical to the operational decision because it directly relates to profitability as it affects cost and revenues. The space allocation influences the buyers’ perceptibility and therefore demand, along with various costs that include ordering, holding, handling, and transportation.

Anderson and Amato (1974) addressed the fundamental short run resource allocation problem by proposing a mathematical model for simultaneously determining the most profitable short run brand mix concurrent with a determination of the optimal shelf space allocation of a fixed display area among the available brand mix. The primary assumption was that the optimal displayed area allocation depends on the composition of brand preference for potential demand—where the potential demand refers to the limit of the inventory of the product displayed that would be sold if all available product brands were displayed. The expected demand function consists of three disjoint components: switching preference demand, non-switching preference demand, and random demand. The random demand represents the attractiveness of the displayed inventory to stimulate demand for those buyers that do not have a brand preference. However, this model did not include the cost effects of inventory.

The mathematical programming model of Hansen and Heinsbroek (1979) proposed a model for maximizing profits by expressing the contributions to profits of all products less the costs associated with replenishing the shelf stock. Incorporating the main demand effect with the cost effect made the model more complete. One major assumption is that while the space elasticity for each unit sales is assumed to be constant, the substitution and complementary effects between products are not explicitly considered.

Corstjens and Doyle (1981) developed a more comprehensive model for optimizing retail space. Their general model proposed to maximize profits by incorporating the “real dimensions of the retailer’s optimization problem”—it is a model that incorporates both the main demand effects with the cost effects of alternative space allocations. The significance of this model is the true nature of the relationship between space and store profitability. Whereas additional space given to a product increases its sales potential, it also affects the sales of other products in the assortment. Hence, ignoring these cross-elasticities and considering only the main demand effects can lead to a sub-optimization in the shelf space allocation procedure. The demand structure defined as a multiplicative power function of the displayed areas allocated to all of the products, which represents the direct elasticity with respect to a unit of shelf space, a scaling constant, the cross space elasticity between products, and the number of products, which is necessary to include the individual space elasticities and the cross space elasticities that exist between products within the store. This provided an advantage