Review on Assortment Problems in Retailing Supply Chain Management

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ABSTRACT
In this paper, we are aimed at reviewing assortment problems integrating pricing strategies, inventory levels and distribution network planning in retail. Through the literature study, we present a comprehensive and updated review and put forward the future directions for assortment study. The main methodology we used is literature study. We classified related papers and reviewed them by different themes. We find that a great number of existing papers related to assortment problems mostly combine the problem of pricing decision, inventory control and distribution design. However, those papers tend to study two or three points above. In other words, there is no literature studying all points simultaneously. Given our findings, we finally propose that it is innovative and valuable to put efforts to study assortment problems combined with pricing, inventory and distribution decisions.

Key words: Assortment; Inventory; Distribution; Pricing

1. INTRODUCTION
The increasing competition in current business has forced the managers to think about how to raise creative strategies and win over a number of competitors. Thus, a growing attention has been paid to assortment management in a product line in stores. Managers start to look for the solutions to many questions such as what is the optimal assortment in a store, how to determine the optimal inventory level in a shop? Determining the best assortment to carry in a store is one of the most central problems in retailing (McIntyre and Miller, 1999) [1].

Assortment refers to a set of goods carried in a store in very time period. The objective of assortment decision is to determine an assortment that maximize sales and gross profit subject to a series of constraints, such as the limited shelf space, a fixed purchasing cycle or lead time, and an optimal inventory level. Therefore, assortment problems are pretty complex and most research tends to combine assortment problems with inventory, distribution, pricing decisions. Although there are a number of papers concentrating on assortment problems, current research pays little attention to assortment problems combined with inventory, distribution and pricing simultaneously. In this paper, we review literature that includes assortment, inventory, distribution and pricing decisions and summarize those studies. Ultimately, we raise several insights into the future research.

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The rest of this paper can be organized as follow. In section 2, we review related literature. Section 3 summarizes the contributions of current research and brings a few further insights into the directions for future research.

2. LITERATURE REVIEW

Product pricing, distribution, inventory and assortment decisions have a key impact on the retailers’ profitability. Yet these decisions have been made somewhat independently due to the complexity resulting from the joint optimization (Katsifou, Seifert and Tancrez, 2014) [2]. In this literature study, we review the papers by different themes, i.e. problem of assortment, distribution and inventory, inventory and assortment, pricing, inventory and assortment. The research studying distribution and inventory mostly considers a multiple-store network and decide optimal inventory, while the literature focusing on inventory and assortment mainly studies optimal inventory in a single store. For both two streams, the frequently used method to determine inventory is newsboy or Economic Order Quantity. In distribution and inventory literature, the research problem tends to be how to distribute and keep optimal stock in stores as well as warehouses. By contrast, distribution problem is ignored in assortment and inventory literature. Such research focuses on the optimal assortment and inventory in a single store. In terms of pricing inventory and assortment problem, a considerable amount of literature focuses on how demand or customer choice varies given different pricing strategies under a fixed assortment with an optimal inventory level. A few papers consider how to price the items for a fixed assortment without inventory decisions.

2.1 Assortment, distribution and inventory

A good distribution network is able to bring a few benefits, for instance, low cost and quick response in supply chain (Chopra, 2003) [3]. The early research (such as Pentico, 1974; Borin, Farris and Freeland, 1994) have studied assortment problem but they do not consider distribution problem. Some classical literature about assortment problem assumes that demand is known with certainty and therefore excludes inventory considerations (Maddah, Bish and Munroe, 2011).

Additionally, a large quantity of papers study distribution problems without assortment decision (Anily and Federgruen, 1990). Miranda and Garrido (2004) propose an approach to distribution network design and inventory decisions [4]. They use continuous inventory review policy to enumerate inventory levels, taking holding cost into consideration. Miranda and Garrido (2008) develop a joint location, distribution and inventory model [5]. The solution is based on Lagrangian relaxation. In another paper, Miranda and Garrido (2009) also study the distribution network design and inventory control problem [6]. Gebennini, Gamberini and Manzini (2009) formulate a cost-based optimization model, in which there is a trade-off between the minimal inventory cost and maximal customer service level [7]. They quantify the safety stock levels in the distribution network. Whereas, those papers integrate distribution and inventory problem, but they ignore the assortment problem.

2.2 Inventory and assortment

Quite a few papers which combine inventory and assortment mainly consider the newsboy setting. The first works which combine assortment with inventory problem are those of van Ryzin& Mahajan (1999) and Smith & Agrawal (2000). Van Ryzin& Mahajan (1999) propose that increasing the breadth of assortment leads to higher sales, which in turn triggers a higher inventory cost. Thus, it is a trade-off between assortment and inventory cost [8]. Based on this
framework, Cachon, Terwiesch & Xu (2005) and Bish & Maddah (2008) study the assortment problem by extending the model [9, 10].

Van Ryzin and Mahajan (1999) explore the inventory and assortment size under MNL model assuming that all items of a category have the same unit cost and price [8]. Li (2007) extends van Ryzin and Mahajan (1999). The difference is that Li (2007) presents a holistic measure-profit rate to estimate profitability of variants (enable the price and cost coefficients to vary across variants) and then make a decision which items should be offered. Agrawal & Smith (2003) and Hariga, Al-Ahmari & Mohamed (2007) study assortment optimization model focusing on retailers’ inventory investment decision[11,12], but Agrawal and Smith (2003) set newsboy inventory model to reach a fixed service level for the items that are in the assortment.

Rodríguez and Aydın (2011) discuss the integration of assortment and inventory in a case where products are configurable [13]. It includes required and optional components and the demand of components is complementary: the change of assortment or price for one component may lead to a different demand for another component. Compared with papers above, Kök and Xu (2011) assume two types of consumer choice model (brand-primary and type-primary) and find that optimal assortment is very different under two customer choice models [14]. In each customer choice model, they formulate different assortment optimization models combined with newsvendor and EOQ inventory model. Katsifou, Seifert and Tancrez (2014) classify consumers into loyal consumer and non-loyal consumer; they group products into two types: special products (lower profit margin and a shorter sales period and aim to increase store traffic by attracting non-loyal) and standard product (offered all year around and aim to attract and retain a steady flow of loyal customers) [15]. In such a background, they throw light on an optimization model to trade off assortment, inventory.

2.3 Pricing, inventory and assortment

In recent ten years, an increasing amount of literature has contributed to the research of the joint pricing, inventory and assortment problem in terms of how to maximize the profit in retail. In the following paragraphs, we review assortment planning based on pricing and inventory decisions. In current research, some papers discuss pricing and inventory problem under a fixed assortment size and the classical literature assumes that demand is known with certainty and therefore excludes inventory considerations (Dobson and Kalish 1993; Green and Krieger 1989; Kaul and Rao 1995).

Assortment models concerned with product prices can better cater for the realistic decision situations for retailers (Murray, Talukdar and Gosavi, 2010) [16]. Such research helps seek for the cross-price effects of various items on demand. However, their model is constrained to retailers who have a pre-selected product assortment. Ghoniem, Maddah and Ibrahim (2014) also investigate assortment and pricing decision for multiple complementary categories under a classical maximum-surplus consumer choice model [17]. They think categories are connected by cross-selling policy. It can be seen that both two papers come up with cross-selling strategy with regard to a category of products while determining pricing and assortment planning.

According to Talebian, Boland and Savelsbergh (2014), discount and promotion early in the sales season can increase demand and bring higher profit [18]. They engage in the investigation of benefits resulting from using price to impact observed sales. Ghoniem and Maddah (2015) formulate a demand model that is also associated with sales season, but they explore a problem that seasonality increases the profit when there is a higher inventory level and wider assortment in a store and suboptimal inventory leads to profit loss [19].

Aydin and Porteus (2008) study optimal inventory level under a fixed assortment [13]. They consider a price-dependent newsboy model under stochastic demand in a single period. Maddah, Bish and Tarhini (2014) also analyze the inventory decisions for a given assortment [20].
Moreover, Maddah, Bish and Tarhini (2014) also discuss assortment and inventory decisions in a way where the price is set with an assumption that there is no salvage value, holding cost and shortage cost, which is the same with Maddah and Bish (2007). Both of two papers use newsboy setting to search for optimal assortment. The difference is that Maddah and Bish (2007) perform MNL method to model static customer choice [21], while Maddah, Bish and Tarhini (2014) consider a multiplicative-additive demand model. Aydin and Porteus (2008) also assume a “multiplicative” demand in the assortment and the demand counts on products’ attractiveness whose function is its own price, so the parameter of the “multiplicative” demand model is independent of pricing decision.

3. DIRECTIONS FOR FUTURE RESEARCH

In conclusion, all papers above do not cover pricing, assortment, inventory and distribution simultaneously. Research related to assortment mainly concentrates on inventory problem, while few papers study assortment and distribution in depth. Most papers above study assortment within a single period and product line. Also, most of them considers MNL model with respect to customer choice. For inventory calculations, most literature uses newsboy model. Furthermore, a few papers study inventory and pricing problems with a fixed assortment decision. Lastly, stockout issues are not considered in all research above.

As a whole, there are several directions for the further study in terms of assortment research. Firstly, it is worthwhile to consider assortment, inventory and distribution decisions simultaneously. So far, there has not been any research combining these three points. In addition, pricing strategies can be also taken into account. Specifically, integrating pricing, assortment, inventory and distribution is also a creative topic.

In the future research, there are also many specific research questions worth investing further. First, the classical customer choice model MNL can be substituted by a different model such as Nested Choice Model (NMNL). Second, for inventory decisions it is also a promising direction to use Economic Order Quantity (EOQ) to determine the optimal order quantity. In addition, under a newsboy setting some literature assume there is no shortage cost, holding cost and salvage cost, which can be taken into account in the further research. Moreover, the most of mentioned papers do not consider the safety stock in stores. Once the assortment solution indicates a certain item is not introduced to some stores, stockout might happen. In this sense, future research can consider safety stock and investigate what differences the solution may be. Additionally, with respect to multiple stores, the above literature assumes there is the same number of consumers in each store, while it is also valuable to explore what if there are various numbers of consumers in each store. Finally, it is also desirable to consider shelf space constraint in the future research.

REFERENCES


