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Inventory Model and Pricing in the Supply Chain Approach VMI Considering Incremental Discount

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ARTICLE INFO	ABSTRACT
<p>Article History: Received 24 January 2022 Received in revised form 25 February 2022 Accepted 22 March 2022 Available online 26 March 2022</p>	<p>Given the globalization of competition and the presence of numerous rivals in today's markets, optimizing the supply chain has become a critical concern for both practitioners and researchers. One of the central challenges in supply chain optimization is achieving a balance between cost reduction and profitability enhancement. Since inventories constitute a significant portion of supply chain costs, determining the optimal inventory level plays a decisive role in minimizing expenses while ensuring responsiveness to demand. Beyond cost management, the ability to capture a larger share of the market is essential for sustaining profitability. Pricing, as a key competitive factor, directly influences customer purchasing behavior and market demand. While price discounts can serve as an effective incentive for increasing sales, they simultaneously lead to higher inventory holding and replenishment costs, thereby creating a trade-off for supply chain managers. This article addresses the joint problem of pricing and inventory control within a bi-level supply chain structure. Specifically, it examines optimal purchasing policies under incremental discount schemes and investigates how pricing strategies can be aligned with inventory decisions to maximize overall performance. To validate the proposed approach, a mathematical model is developed and solved using illustrative numerical examples, demonstrating the practical implications of integrated pricing and inventory optimization.</p>
<p>Keywords: Supply Chain Management, VMI Approach for Inventory Control, Incremental Discount, Pricing.</p>	

1. INTRODUCTION

The growing trend of competitive global economy today has led companies to take advantage of supply chain management to increase their competitiveness and productivity. Supply chain management is an attitude that has attracted the attention of organizations and companies that are considering global surface activity in the recent years [1]. Vendor-managed inventory management (VMI) in the supply chain is a relatively new system in which the supplier is responsible for controlling and redeeming the retailer's inventory. In recent years, with the advent of information technology on the one hand and increasing competition on the other hand, this system has been

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addressed by many supply chains. Therefore, in this article, a model based on vendor's inventory management system is presented.

The incremental discount is applied to each range individually, in other words, all purchased units are not purchased with a single unit price, but the discount is defined and based on the values within the discount range for each product unit. Since supply chain discounts in the supply chain are falsely affecting demand, this article examines the management of supply chain management based on inventory management by vendor in the presence of incremental discounts.

2. LITERATURE REVIEW

Inventory management and control is one of the dimensions of supply chain management that can play an important role in establishing coordination among supply chain members. In the traditional supply chain, each member is responsible for deciding on their management inventory [2]. In recent years, there have been new approaches to inventory in the supply-chain, whose main idea is to transfer responsibility for decisions on the management inventory of each loop to loop. In these approaches, each member of the chain has information about the demand to the upstream member and the relevant decisions in return for the inventory, in most cases, the inventory maintains the inventory and accepts the risk of demand uncertainty [3].

Vendor's management inventory is one of the most popular collaborative ways to increase the supply chain efficiency that was founded in the early 1980's. Today, vendor's management inventory has a very key role to play in small and large supply chains that have a fast response capability to customers. The supplier's vendor, sometimes the vendor distributor, takes decisions on inventory control for the consumer, in other words, the vendor controls the inventory level of the buyer (physically or electronically), and the decisions related to issuing order registration, order quantity, z man order, shipping, etc. In this interaction, the customer abandons the inventory control of his warehouse, and sometimes assigns responsibility to the supplier for all of his financial operations, or that it can be said that the management inventory by the vendor continuous process in this case, the responsibility of the customer management inventory is assigned to the supplier [4].

Yo et al (2012) [5] studied a VMI supply chain with raw material and a rotting product. In their model, the rate of corruption was known and fixed, and demand retail was definitively considered. They developed a vmi model to calculate the total cost of inventory and corruption. In this model, the re-product cycle and the number of raw material re-repressions were considered as decision variables. In addition, they proved the constraint of the cost function for solving the model. They then used the golden search algorithm.

Sankarasana [6] studied an inventory model for perishable goods in a supermarket. In this model, goods began to corrupt after a certain time with a probability distribution function. The model's strategy was to stimulate customer demand using a decline in sales prices. After analyzing the model, the demand function was considered as an incremental function of the drop in sales price. In the end, computational methods were used to analyze and maximize the yield function. Numerical examples were also provided for sensitivity analysis of the model. He proposed to consider inflation and the time value of money as the development of their model in the future.

Kasegar [7] in the article, the product discounts included in the product are based on the product lifetime of the vmi model.

Pasandideh [8] the vendor inventory management inventory (VMI) introduced a single buyer's single vendor supply chain, in which the vendor is responsible for managing the inventory management of the buyer. In order to involve widespread applicability in real-world environments, multi-product pre-purchase multi-product quantitative production model was considered under three storage capacity limitations, number of orders and budget available. Non-linear programming model this first issue was raised to determine the orderly value of the order along with the maximum level of pre-purchase products in a cycle, so that the total cost of the inventory of the VMI system was minimized. Then, an initiative based on genetic algorithm (GA) was proposed to solve this model.

Hosseini [9] a supply chain survey with vendor inventory control (VMI) control conditions was conducted with upstream and downstream supply chains and a supply chain with a retailer with a randomized demand demand storage limited capacity. In this article the delivery time varies depending on the volume of the cargo and the demand for the uniform distribution.

Nasrollahi [10] a supply chain bi-level, including a manufacturer and a retailer, was considered. This supply chain is under the VMI system and the decision on inventory levels is taken centrally by the manufacturer and the manufacturer is responsive to retail needs. The manufacturer generates a finite rate based on custom production policy, and each custom stack sends the custom q retail with several smaller digits q for retail. The demand for retail is poisson type and inventory retail is provided with the policy (r, q) by the manufacturer.

This article examines how to determine the amount of optimal sale and discount considering the existence of incremental discounts and a shortage of multivariate products with the vmi approach with the goal of cost reductions, which has been underestimated by literature review.

The aspect of innovation and the novelty of the research in this article is to consider simultaneously the inventory and pricing problem, taking into account the incremental discounts in the vmi strategy.

3. PROPOSED MODEL

In this section, the vmi model is discussed in a supply-chain bi-level, including vendor and retail. A vendor with fixed rate and limited production supplies retailers. The hypotheses of the model are :

- Demand for custom product is provided by price product
- Product shortage is allowed in retail
- Multi product model
- Discounts are incremental
- The instant renewal rate is zero, and the delay time is zero.
- Deficiency is not allowed.

Index:

I: index products
 K_i: discounts for products i
 J: index vendor

Parameters:

S_i: cost maintenance of each product unit i in stock
 Tc_{ij}: price buy product after offering discount incremental
 C_{ij}: price buy product i at interval discount j
 Bg: the budget is in the hands of the buyer
 D_{ij}: lower limit discount product i in interval j
 D_{uj}: upper limit discount product i in interval j
 A_i: demand market potential for product i
 B_i: effect factor of price

Variables

D_i (p_i): expected function demand for product i
 D_i: demand for product i
 P_i: price sale product i
 Q_{ij}: buy product i value at interval discount j
 Y_{ij}: if the buyer purchases product i in interval discount j 1 otherwise 0

Function the objective of the model is to maximize profits:

$$Max \ zc = \sum_i p_i * d_i - \sum_i s_i * z_i - \sum_i \sum_j TC_{ij} * y_{ij} \quad (1)$$

In function, the goal 1 is the sales gain, the second is stored cost and the third is cost buy.

$$\sum_i \sum_j TC_{ij} * y_{ij} \leq BG \quad (2)$$

Limitation 1 : this limitation requires purchasers to purchase buyer's products at a lower rate than purchasers.

$$dl_{ij} * y_{ij} \leq q_{ij} \leq du_{ij} * y_{ij} \quad \forall i, j \tag{3}$$

Limitation 2 : buy product i at interval discount j

$$\sum_j y_{ij} = 1 \quad \forall i \tag{4}$$

Limitation 3 : the limit specifies just one interval discount

$$TC_{ij} = TC_{ij-1} + C_{ij} * (q_{ij} - du_{ij-1}) \quad \forall i, j \tag{5}$$

Limitation 4 : limits the cost of buy product i and is based on buy and discount incremental

$$Di=ai-bipi \tag{6}$$

Limitation 5 : function demand is the buyer

$$TC_{i0} = 0 \quad \forall i \tag{7}$$

Limitation 6 : cost buy first takes zero

$$z_i = \sum_i \sum_j Q_{ij} - d_i \tag{8}$$

Limitation 7 : inventory from product i

$$p_i \geq 0$$

$$ai \geq 0$$

$$y_{ij} \in \{0,1\}$$

$$TC_{ij} \geq 0$$

We will continue to solve numerical examples for the model.

Numerical examples:

In numerical examples 2 product is assumed to have the following specifications:

Demand potential for product 1: a1: 7000

Demand potential for product 2: a2: 6500

Budget limit: bg: 12500

According to the assessment, function demand for products is as follows:

Table 1. Function demand for products

Product	P1	P2
Demand potential	7000	6500
Maintenance cost	1.4	1.6

Budget limitation (bg): 12500

Incremental discount rate for buy products:

Table 2. Incremental discount rate for buy products

Purchase rate	0-2000	2001-4000	4000 More than
Price buy product c12	7	6.65	6.3
Price buy product c22	8	7.6	7.2

The results obtained from the model solving by lingo software are:

Table 3. The model solving by lingo software

Product	P1	P2
Price sale product	27.3	54.16
Amount demand	3378	2001

Cost maintenance each product unit 1 in stock 1.4 and cost maintenance product ii is 1.6.

Solve numerical examples:

The results obtained from the model solving by lingo software are:

The amount of buy products in discount intervals:

Product 1: $q_{13} = 4001$

Product 2: $q_{22} = 2001$

Total profit = 78150+

The results of the model show that considering the possibility of using more discounts and considering the cost maintenance of the model, in some cases, it would prefer to buy less discount in discount mode.

4. CONCLUSION

Given the fundamental role inventories make in organizational costs, determining their optimal levels can lead to significant cost reductions and, on the other hand, the sales-based gain from the demand, which is the price-based demand itself.

Therefore, in this article, in the supply chain bi-level, the optimal pricing policy in the inventory is addressed. The mathematical model written with the assumption of multi product mode and the existence of the incremental discounts to calculate the optimal buy based on the discount and determine the amount of optimal sale in the supply chain incremental discounts are discounts in which all purchased goods are not purchased with a price, but price buy is determined depending on the discount intervals. Regarding the general perception of using discounts, paying attention to cost maintenance can lead to a significant increase in costs. Therefore, in this article, optimal policy attempts to increase the amount of buy and price in the incremental discount mode in order to maximize the modeling profit and to be solved. The problem was based on the hypothesis taken as a one-goal to maximize earnings by considering the incremental limitation of the modeling budget and solving software lingo and optimal buy values were obtained at discount intervals and price optimal sale.

5. SUGGESTS FOR FURTHER RESEARCHES

1. Shortage in model to be considered.
2. Model using game theory to be solved.
3. Parameters model fuzzy be considered.
4. Select suppliers issue to model add to.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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