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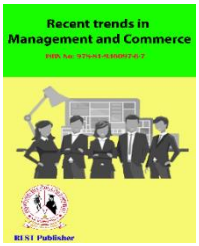

Effective Inventory Management with Drop Shipping Strategies

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Abstract: *Inventory management is significant for effective business operations. The managerial decision makers are devising feasible strategies to handle the fluctuating demands of the customers. As the traditional inventory models lack the competency in balancing holding costs and stockouts, there is a need for developing robust inventory models with innovative approach of demand fulfillment. Dropshipping is one such strategy practiced widely at recent times by the retailers to fulfil the demands of the customers directly. This research work proposes a flexible inventory model integrating drop shipping strategy and its associated cost parameters. The developed model is substantiated with a case study and validated using numerical illustration. Sensitivity analysis is performed to compare inventory models with and without drop shipping parameters.*

Keywords: *Inventory Model, Dropshipping, Demand fulfillment, Strategy*

1. INTRODUCTION

The dynamic supply chain management together with highly competitive market are the challenging factors of business operations in fulfilment of customer's demands. These operative hurdles shall be well handled with effective principles of inventory management. In case of traditional inventory management, bulks of products are stocked with high holding costs to prevent stock outs, however at some instances, this conventional approach fails to meet out the fluctuating demands of the customers. The contemporary inventory management incorporates the strategy of drop shipping in demand fulfillment to prevent shortages. Although, the concept of drop shipping has been introduced earlier, it is gaining more momentum only at recent times. Several companies have adopted this strategy especially the online stores and E-commerce businesses. One of the striking features of drop shipping is direct transaction between suppliers and the customers there by minimizing the stocking costs and opportunity costs. Researchers have explored the notion of drop shipping in diverse contexts. Some of the noteworthy contributions are discoursed. Chaka [2] discussed drop shipping in the scenario of internet shop. Zodiac[14] explained as a logistic business model of e-commerce. Ezeanaka[5] described the ways of building economy using drop shipping. Corrotea Reyes [3] explored the potency of drop shipping models with special reference to Chile. Mostarac et al [11] briefed the need of integrating dropshipping in supply chain. Sobiech[13] proposed taxation blended logistic model with dropshipping. Ivaniuk[7] highlighted the significance of dropshipping and its utilization in modern business. Maniciati [10] discussed dropshipping with reference to Italian market. Koroljov [9] explained the dropshipping business model in E-commerce. Hrytsenko et al [6] suggested dropshipping based business model in developing a web-oriented system. Kolyandov[8] developed dropshipping based online business model to cater to the demands of customers in E-commerce. Renon et al[12] illustrated the efficacy of dropshipping model in furniture handling and transportation. Dimitrova[4] focused on the advantages of dropshipping in small and medium sized enterprises. Angulo et al[1] discussed M-commerce based dropshipping model. From the aforementioned brief literature, it is evident that the dropshipping strategy is closely associated with E-commerce platforms and it is employed as an effective business tool to boost the economy. Although dropshipping is discussed in the context of supply chain management, only theoretical

framework is focused and no concrete mathematical model is developed incorporating the elements of inventory modelling architecture. This has inspired the authors to develop an inventory model integrating the notion of dropshipping and its pertinent cost parameters. The other contents are discussed into the following segments. The model development is presented in section 2. Case study illustration and numerical example is presented in section 3. Sensitivity analysis is presented in section 4. The last section concludes the work. This paper presents a mathematical framework for inventory optimization that integrates both stocking and dropshipping strategies. The model aims to determine the optimal order quantity that minimizes total costs while ensuring product availability. The study also explores the implications of dropshipping on inventory replenishment cycles, lead times, and cost structures. By analyzing different scenarios, we provide insights into how businesses can effectively integrate dropshipping into their inventory management systems for improved operational performance.

2. MODEL DEVELOPMENT

Problem Description: Let us consider the situation where the retailer fulfils the demands of the customers using a dual mode of demand fulfillment using regular and dropshipping. The retailer is encountering the problem of storage capacity and warehouse management; therefore, he decides to fulfil a portion P_{ads} of the demand using dropshipping and the remaining using the regular mode. By considering this decisioning problem, the inventory model is developed to determine the optimal order quantity and the total inventory cost. The model developed is very fundamental comprising primary costs.

Notations:

The notations are presented as follows

- D −Annual demand
- C_o − Ordering cost per order
- C_h −Holding cost per unit per year
- C_{ds} − Dropshipping cost per unit
- P_{ds} −Proportion of demand fulfilled via dropshipping
- Q − Order quantity per cycle

Assumptions:

- Demand is deterministic.
- No shortages are allowed.
- Time horizon is finite.

Now, demand is split into two parts:

Stocked Inventory Demand: $(1 - P_{ds})D$ → Fulfilled from regular stock
Dropshipping Demand: $P_{ds}\,D$ → Fulfilled through drop shipping

Total Cost Function with Dropshipping

The total annual cost consists of:

- **Ordering Cost**

$$T_{C_o} = \frac{D}{Q} C_o$$

- **Holding Cost** (only for stocked items)

$$T_{C_h} = \frac{(1 - P_{ds})D}{Q} C_h$$

- **Dropshipping Cost:**

$$TC_{ds} = P_{ds} D C_{ds}$$

Thus, the total cost function becomes:

$$TC = \frac{D}{Q} C_o + \frac{(1 - P_{ds}) D}{Q} C_h + P_{ds} D C_{ds}$$

Optimizing Q to Minimize Cost

- To find the optimal order quantity Q^*, we take the derivative of TC with respect to Q and set it to zero:
- $\frac{dTC}{dQ} = \frac{DC_o}{Q^2} + \frac{(1-P_{ds})C_h}{2} = 0$
-
- Solving for Q^*:
- $Q^* = \sqrt{\frac{2DC_o}{(1-P_{ds})C_h}}$
- If $P_{ds} = 0$ (no dropshipping), this reduces to the classical EOQ:
- $Q^* = \sqrt{\frac{2DC_o}{C_h}}$

3. CASE STUDY ILLUSTRATION AND NUMERICAL EXAMPLE

To illustrate the Effective Inventory Management with Dropshipping Strategies, let's consider the case of an electronics retailer that sells smartphones, laptops, and accessories. The retailer fulfils customer orders through two channels:

1. Stocking Inventory – The retailer holds stock in its warehouse and ships directly to customers.
2. Dropshipping – For some products or during demand surges, the retailer fulfils orders by placing them directly with suppliers, who ship them to customers.

Given:

- $D = 10{,}000$ units/year
- $C_o = 50$ per order
- $C_h = 2$ per unit/year
- $C_{ds} = 10$ per unit
- $P_{ds} = 0.2$ (20% demand fulfilled via dropshipping)

Therefore,

$$Q^* = \sqrt{\frac{2(10{,}000)(50)}{(1-0.2)(2)}}$$

$$Q^* = \sqrt{\frac{1{,}000{,}000}{1.6}} = 790.57 \approx 791$$

Comparison with Classical EOQ: Classical EOQ (no drop shipping): 707707707, New EOQ (with drop shipping): 791791791. Thus, with 20% drop shipping, the retailer should order more stock (791 units instead of 707) per cycle to balance inventory and drop shipping costs.

4. SENSITIVITY ANALYSIS

Sensitivity analysis is performed to explore how dropshipping percentage (Pds) influences multiple factors such as holding cost (Ch), dropshipping cost (C_ds),total cost (TC), optimal order quantity (Q). Python programming is used to draw sensitivity analysis results and graphs. The changes in costs and quantity with respect to changes in dropshipping percentages varying from 0 to 100 is presented in Table 1.

TABLE 1. Sensitivity Analysis

Dropshipping P_{ds} in %	**Holding Cost C_h**	**Dropshipping CostC_{ds}**	**Total Cost TC**	**Optimal Order Quantity Q**
0	707.106781	0.0	1414.213562	707.106781
0.05	689.202438	5000.0	6378.404875	725.476250
0.1	670.820393	10000.0	11341.640786	745.355992
0.15	651.920241	15000.0	16303.840481	766.964989
0.20	632.455532	20000.0	21264.911064	790.569415
0.25	612.372436	25000.0	26224.744871	816.496581
0.30	591.607978	30000.0	31183.215957	845.154255
0.35	570.087713	35000.0	36140.175425	877.058019
0.40	547.722558	40000.0	41095.445115	912.870929
0.45	524.404424	45000.0	46048.808848	953.462589
0.50	500.000000	50000.0	51000.000000	1000.000000
0.55	474.341649	55000.0	55948.683298	1054.092553
0.60	447.213595	60000.0	60894.427191	1118.033989
0.65	418.330013	65000.0	65836.660027	1195.228609
0.70	387.298335	70000.0	70774.596669	1290.994449
0.75	353.553391	75000.0	75707.106781	1414.213562
0.80	316.227766	80000.0	80632.455532	1581.138830
0.85	273.861279	85000.0	85547.722558	1825.741858
0.90	223.606798	90000.0	90447.213595	2236.067977
0.95	158.113883	95000.0	95316.227766	3162.277660
1.00	0.000000	100000.0	100000.0	0.000000

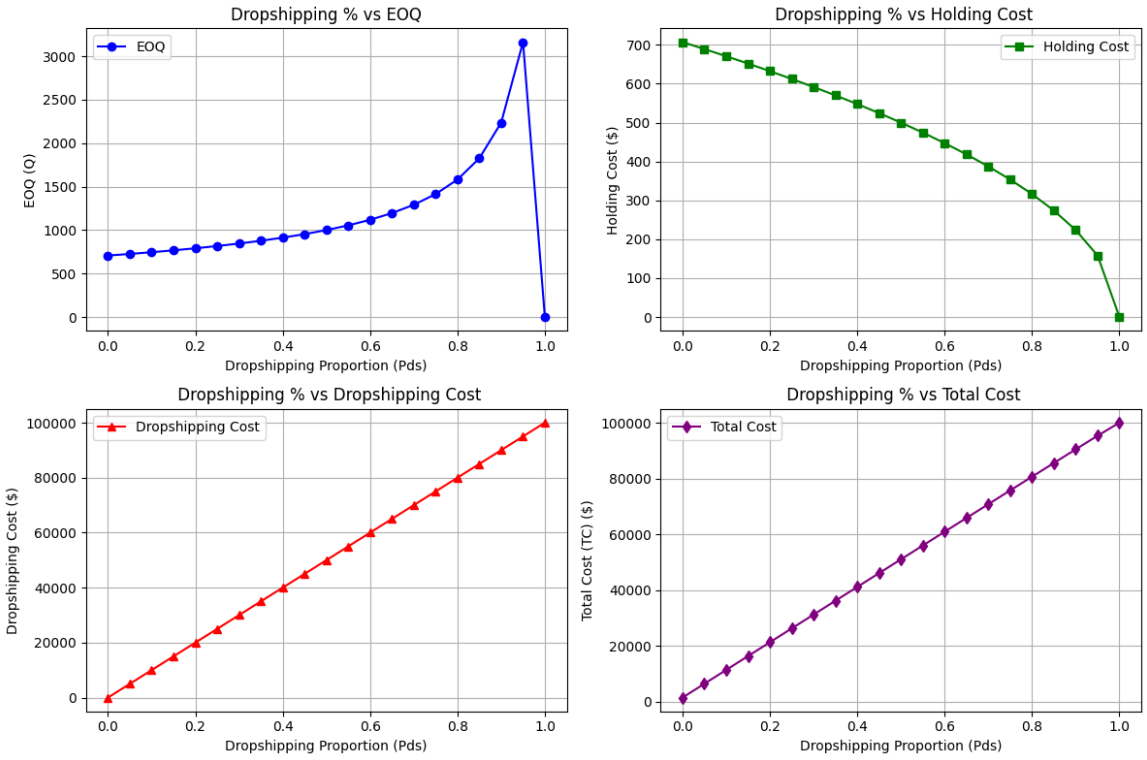

FIGURE 1. The graphical representation of the above table values is presented

Sensitivity Analysis of Dropshipping over Cost and Oder Quantitybrand loyalty
B Inferences

•EOQ (Economic Order Quantity) Trends:

- When Pds = 0 (No Dropshipping), EOQ is 707.11 units, as all orders are fulfilled from inventory.
- As Pds increases, EOQ gradually increases, reaching 3162.28 units at Pds = 0.95 before dropping to 0 at Pds = 1 (Full Dropshipping).

- This indicates that when dropshipping is introduced, inventory holding is still necessary, but at Pds = 1, no inventory is needed. Holding Cost Dynamics: 4 • When Pds = 0, the holding cost is highest at $707.11.
    - As Pds increases, holding cost steadily decreases due to reduced reliance on stored inventory.
    - At Pds = 1, holding cost reaches $0, as all orders are fulfilled via dropshipping.
    - Dropshipping Cost Impact:
    - When Pds = 0, dropshipping cost is $0 (as no units are drop shipped).
    - As Pds increases, dropshipping cost rises linearly, reaching $100,000 at Pds = 1.
    - This shows a direct trade-off between inventory holding cost and dropshipping cost.

Total Cost Analysis:

- At Pds = 0 (No Dropshipping), the total cost is $1414.21.
- As Pds increases, total cost rises significantly due to increasing dropshipping costs.
- At Pds = 1 (Full Dropshipping), total cost reaches $100,000, which is substantially higher.
- This indicates that a balance between dropshipping and inventory stocking is crucial to minimize total cost.

5. CONCLUSION

This research work proposes an economic order quantity-based inventory model considering the notion of dropshipping and its related costs. The proposed inventory model integrates dropshipping parameters and studies the effects of dropshipping over different costs parameters and order quantity. This research work suggests hybrid inventory strategy following dual mode of demand fulfillment. Though drop shipping reduces the holding costs it increases the total costs and thereby the decision makers must set a balance between the quantities of dropshipping and regular inventory stocking.

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