CHAPTER 7

OPTIMAL LOT SIZE IN JIT PURCHASING CONSIDERING DUOPOLISTIC SITUATION WITH RESPECT TO INVENTORY TURNOVER RATIO IN FIXED MARKET
7. CHAPTER 7: OPTIMAL LOT SIZE IN JIT PURCHASING CONSIDERING DUOPOLISTIC SITUATION WITH RESPECT TO INVENTORY TURNOVER RATIO IN FIXED MARKET

7.1. Introduction:
This chapter deals with the determination of the given product to maximize the Inventory Turnover Ratio of a brand under consideration, when rival brand is also trying to maximize Inventory Turnover Ratio by optimizing the lot size level in the fixed market as well as in the varying markets. For this purpose, the model suggested by Ramasesh is used to obtain the optimum order quantity under some simplified assumptions in JIT purchasing.

Here, we have interested in determining optimum lot size for the product when rivalry is only limited to the fixed market, using the model developed by Ramasesh (1990).

7.2.1. Assumption and Notations:
(i) Only two brands of a product are competing in the market.
(ii) The total anticipated sales volume V of the product is fixed.
(iii) Let the annual demand of the \( i^{th} \) brand \( D_i \) be unknown and it is assumed that it depends on the competitor brand's strategy.
(iv) Let total number of shipments \( N_i \) of quantity purchased be known for \( i^{th} \) brand, \( i=1,2 \). and \( Q_i \) denote the contract quantity of \( i^{th} \) brand.
(v) Logistic margin \( (h_i) \) of \( i^{th} \) brand is defined as the difference between unit price \( (p_i) \) and unit variable cost \( (C_{A_i}) \) for \( i=1,2 \).
(vi) Shortages are not allowed.
(vii) Purchasing of the commodity is uniform.

(viii) Lead time is Zero

(ix) Each competitor brand not only knows its number of shipments, inventory holding cost and logistic margin but also the same for the opponent brand and tries to maximize its ITOR.

(x) The competitor brand's share of market depends on its relative demand in the market.

(xi) \( n \), denote the total numbers of runs of quantity produced be known for \( i^{th} \) brand.

(xii) \( H_i \), is the inventory holding cost for \( i^{th} \) brand (per unit per year) for \( i = 1, 2 \)

(xiii) \( S_i \), is aggregate cost per shipment including freight cost, inspection cost, handling, storage and associated opportunity costs for \( i^{th} \) brand. \( i = 1, 2 \)

(xiv) \( A_i \), is the cost of placing an order for \( i^{th} \) brand, for \( i = 1, 2 \).

### 7.2.2. Problem Formulation:

Considering the model defined by Ramasesh (1990), the total annual operating cost is given by

\[
C_{A_i} = \frac{A_i D_i}{Q_i} + \frac{N_i S_i D_i}{Q_i} + \frac{Q_i H_i}{2N_i} \quad \ldots \quad 7.1
\]

Here, we consider a fix market in which only two brands are competing and total market potential represents the total anticipated sales of both the competitors under a given set of strategies.

The contribution of demand to the market share of the \( i^{th} \) brand is proportional to \( M_i \), for \( i = 1, 2 \) respectively. Therefore total anticipated sales of \( i^{th} \) brand is defined as \( VM_i h_i \). Then the Inventory Turn over Ratio for \( i^{th} \) brand is given by,
\[ I(Q_i) = VM_i h_i \left[ \frac{A_i D_i + N_i S_i D_i + Q_i H_i}{Q_i} \right] \]

Where \( M_i = \left[ \frac{n_i Q_i}{n_i Q_1 + n_i Q_2} \right] \) and \( D_i = N_i Q_i \)

\[ = V \left[ \frac{n_i Q_i}{n_i Q_1 + n_i Q_2} \right] h_i \left[ A_i N_i + N_i^2 S_i + \frac{Q_i H_i}{2N_i} \right] \]

\[ = \left( n_i Q_i \right) \frac{n_i Q_1 + n_i Q_2 - h_i}{n_i Q_1 + n_i Q_2} \left[ A_i N_i + N_i^2 S_i + \frac{Q_i H_i}{2N_i} \right] \]

\[ \text{......} \quad 7.2 \]

where \( i = 1, 2 \).

\[ I(Q_1) = V \left[ \frac{n_1 Q_1}{n_1 Q_1 + n_2 Q_2} \right] h_1 \left[ A_1 N_1 + N_1^2 S_1 + \frac{Q_1 H_1}{2N_1} \right] \]

\[ \text{......} \quad 7.3 \]

and \[ I(Q_2) = V \left[ \frac{n_2 Q_2}{n_1 Q_1 + n_2 Q_2} \right] h_2 \left[ A_2 N_2 + N_2^2 S_2 + \frac{Q_2 H_2}{2N_2} \right] \]

\[ \text{......} \quad 7.4 \]

Since both \( Q_1 \) and \( Q_2 \) are positive, the necessary and sufficient conditions for maximize the ITOR of \( i^{th} \) competitor \((i=1,2)\) are given by,

\[ \frac{\partial I(Q_i)}{\partial Q_i} = 0 \quad \text{and} \quad \frac{\partial^2 I(Q_i)}{\partial Q_i^2} < 0 \]

From 7.3 we have,

\[ \frac{\partial I(Q_1)}{\partial Q_1} = V h_i \left[ \frac{n_1 n_2 Q_2}{(n_1 Q_1 + n_2 Q_2)^2} \right] \left[ N_1 A_1 + N_1^2 S_1 + \frac{Q_1 H_1}{2N_1} \right]^{-1} \]

\[ V h_i \left[ \frac{n_1 Q_1}{(n_1 Q_1 + n_2 Q_2)} \right] \left[ N_1 A_1 + N_1^2 S_1 + \frac{Q_1 H_1}{2N_1} \right] \left[ \frac{H_1}{2N_1} \right] = 0 \]

\[ \Rightarrow V h_i \left[ \frac{n_1 n_2 Q_2}{(n_1 Q_1 + n_2 Q_2)^2} \right] \left[ N_1 A_1 + N_1^2 S_1 + \frac{Q_1 H_1}{2N_1} \right] = V h_i \left[ \frac{n_1 Q_1}{(n_1 Q_1 + n_2 Q_2)} \right] \frac{H_1}{2N_1} \]

\[ \Rightarrow \frac{n_1 Q_1}{n_1 Q_1 + n_2 Q_2} \left[ N_1 A_1 + N_1^2 S_1 + \frac{Q_1 H_1}{2N_1} \right] = \frac{Q_1 H_1}{2N_1} \]

\[ \text{......} \quad 7.5 \]

and \[ \frac{\partial^2 I(Q_1)}{\partial Q_1^2} < 0 \]
From 7.4 we have,

$$\frac{\partial h(Q_2)}{\partial Q_2} = \frac{n_1n_2Q_1}{(n_1Q_1 + n_2Q_2)} \sqrt{N_2A_2 + N_2^2S_2 + \frac{Q_2H_2}{2N_2}}$$

and

$$\frac{\partial^2 h(Q_2)}{\partial Q_2^2} < 0$$

From result 7.5 and 7.6, we have,

$$\frac{2N_1n_2Q_2}{Q_1H_1} \left[ N_1A_1 + N_1^2S_1 + \frac{Q_1H_1}{2N_1} \right] = n_1Q_1 + n_2Q_2$$

and

$$\frac{2N_2n_1Q_1}{Q_2H_2} \left[ N_2A_2 + N_2^2S_2 + \frac{Q_2H_2}{2N_2} \right] = n_1Q_1 + n_2Q_2$$

From 7.7, we have,

$$n_1H_1 \left[ N_1A_1 + N_1^2S_1 \right] = n_1Q_1$$

and

$$\frac{2N_1n_2Q_2}{Q_1H_1} \left[ N_1A_1 + N_1^2S_1 \right] = n_1Q_1$$

From 7.9, we have,

$$Q_2 = n_1Q_1H_1 / \left[ 2N_1n_2\left( N_1A_1 + N_1^2S_1 \right) \right]$$
From 7.8, we have,
\[
2N_i n_i Q_i \left[N_i A_i + N_i^2 S_i \right] = Q_i^2
\]
\[
\therefore\quad 2N_i n_i Q_i \left[N_i A_i + N_i^2 S_i \right] = \frac{n_i Q_i^2 H_i^2}{4N_i n_i^2 \left(N_i A_i + N_i^2 S_i \right)^2}
\]
\[
\therefore\quad Q_i = \frac{8N_i^2 n_i^2 \left[N_i A_i + N_i^2 S_i \right] \left[N_i A_i + N_i^2 S_i \right]}{n_i H_i^2 H_i^2}
\]
\[
\therefore\quad Q_i = \frac{8N_i^2 n_i^2 \left[N_i A_i + N_i^2 S_i \right] \left[N_i A_i + N_i^2 S_i \right]}{n_i H_i^2 H_i^2} \quad \cdots \quad 7.10
\]

Similarly from results 7.7 and 7.8 we get,
\[
\therefore\quad Q_2 = \frac{8N_i^2 n_i^2 \left[N_i A_i + N_i^2 S_i \right] \left[N_i A_i + N_i^2 S_i \right]}{n_i H_i^2 H_i^2} \quad \cdots \quad 7.11
\]

\[
\therefore\quad C_{A_i} = \left[A_i N_i + N_i^2 S_i \frac{H_i}{2N_i} Q_i \right] \quad \text{for } i = 1, 2. \quad \cdots \quad 7.12
\]

\[
\left(\frac{Q_i}{Q_i} \right) = VM \cdot \frac{h_i}{C_{A_i}} \quad \text{for } i = 1, 2. \quad \cdots \quad 7.13
\]

### 7.2.3. Hypothetical Problem:-

Let us suppose that any two brands are competing in the market in which total anticipated sales of product is fixed and it is \(V=10000\) units. Other information regarding the problem is as bellow:

<table>
<thead>
<tr>
<th>Brand</th>
<th>Cost of placing an order (Rs/Order) (A_i)</th>
<th>Holding Cost (Unit/Year) (H_i)</th>
<th>Aggregate cost per shipment (Rs/shipment) (S_i)</th>
<th>No of Shipment (per contract) (N_i)</th>
<th>Total No. of runs of quantity produce (n_i)</th>
<th>Logistic margin (Rs/Unit) (h_i)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>25</td>
<td>1.0</td>
<td>25</td>
<td>4</td>
<td>5</td>
<td>3.00</td>
</tr>
<tr>
<td>II</td>
<td>30</td>
<td>1.5</td>
<td>29</td>
<td>5</td>
<td>6</td>
<td>2.50</td>
</tr>
</tbody>
</table>
Solution of the problem is as bellow:

Chapter 7 : Model 1 : Problem Formulation

<table>
<thead>
<tr>
<th>Brand</th>
<th>Optimal Demand (Units)</th>
<th>Optimal Turnover D</th>
<th>Total Inventory Cost (Qopt) C(Qopt)</th>
<th>Optimal Inventory Turnover I(Qopt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>24101</td>
<td>4820</td>
<td>1103</td>
<td>12.34</td>
</tr>
<tr>
<td>II</td>
<td>29044</td>
<td>4841</td>
<td>1601</td>
<td>8.53</td>
</tr>
</tbody>
</table>

7.2.4. Remarks:

Under situation stated in the model it is clear from the solution of the hypothetical problem that ITOR of brand-I is greater than its rival brand-II. In competitive market it always good to obtain higher ITOR. Therefore, the results justify that inventory management brand-I is more efficient than rivalry brand.

7.3. Multiple Operation Lot Size in JIT Purchasing Considering Duopoliastic Situation With Respect To Inventory Turnover Ratio

7.3.1. Introduction:

This model deals with the determination of the optimum lot size for two brands of given product to maximize the inventory turnover ratio of a brand under consideration when rival brand is also trying to maximize its ITOR by optimizing the lot size level in fixed market. For this purpose, the model suggested by Grout and Seastrand (1987) is used to develop the lot sizes for products requiring multiple serial operations in the JIT environment in competitive situations.

7.3.2. Assumption and Notations:

(i) Only two brands of a product are competing in the market.

(ii) Shortages are not allowed.

(iii) Production of the commodity is uniform.
(iv) Lead time is Zero
(v) Each competitor brand not only knows its number of production runs, inventory holding cost and logistic margin but also the same for the opponent brand and tries to maximize its profit.
(vi) The competitor brand’s share of market depends on as relative demand in the market.
(vii) The total anticipated sales volume (V) of the product is fixed.
(viii) Let demand of $j^{th}$ brand ($D_j$) is unknown and it is assumed that it depends on the competitor brand’s strategy.
(ix) Let total number of runs ($n_j$) of quantity produced be known for $j^{th}$ brand, $j = 1, 2$ and $Q_j$ denote the lot size in each production run of $j^{th}$ brand.
(x) Logistic margin ($h_j$) of the brand is defined as the difference between unit price ($P_j$) and unit variable cost ($C_j$) for $j = 1, 2$.

7.3.3. Problem Formulation:

Considering the model defined by Grout and Seastrand (1987), the total cost is given by,

$$T(Q_j) = \sum_{r=1}^{n} \left[ (N_j + P_j)Q_j R_j + \frac{D_j}{Q_j} (L_j S_j + M_j) \right] \quad \ldots \ldots \quad 7.14$$

Here, we consider a fix market in which only two brands are competing and total market potential represents the total anticipated sales of both the competitions under a given set of strategies.

The contribution of demand to the market share of the $j^{th}$ brand is proportional to, $M_j$ for $j=1,2$ respectively.

Thus, the share of market $M_j$ for the $j^{th}$ brand is given by,
Total anticipated sales value for $j^{th}$ brand is given by

$$V_j = VM_j h_j \quad \ldots \quad 7.15$$

Where $V$ is fixed anticipated unit sales value

$h_j$ is logistic margin

The problem here is to find equilibrium points for the both the competitor brands in the sense that if any brand deviates from the equilibrium value, ITOR goes down. Using 7.14 and 7.15 we get.

$$I(Q_j) = \frac{V_j}{Total\ Cost} = \frac{V_j}{T(Q_j)}$$

$$= \frac{V}{\sum_{i=1}^{n} \left( (N_i + P_j)Q_iO_iR_i + \frac{D_i}{Q_j} (L_iS_{ij} + M_i) \right)} \cdot h_j, \quad j = 1, 2.$$ 

Let us take $L_iS_{ij} + M_i = b_i$ and

We have $D_i = n_jQ_0$ \quad ; \quad j = 1, 2, \quad so,

$$I(Q_j) = V \left[ \frac{n_jQ_j}{n_1Q_1 + n_2Q_2} \right] h_j \sum_{i=1}^{n} \left( (N_i + P_j)Q_iO_iR_i + n_i b_i \right) \quad \ldots \quad 7.16$$

The necessary and sufficient condition for maximum ITOR of $j$th competitor ($j = 1, 2$) are given by, \( \frac{dI(Q_j)}{dQ_j} = 0 \) and \( \frac{d^2I(Q_j)}{dQ_j^2} < 0 \)

From 7.16, for $j = 1$,

$$I(Q_1) = V \left[ \frac{n_1Q_1}{n_1Q_1 + n_2Q_2} \right] h_1 \sum_{i=1}^{n} \left( (N_i + P_i)Q_iO_iR_i + n_i b_i \right)$$

$$\frac{dI(Q_1)}{dQ_1} = V h_1 \left[ \frac{n_1n_2Q_2}{(n_1Q_1 + n_2Q_2)^2} \right] \cdot \left( \sum_{i=1}^{n} \left( (N_i + P_i)Q_iO_iR_i + n_i b_i \right) \right)^{-1}$$

$$+ V \left[ \frac{n_1Q_1}{n_1Q_1 + n_2Q_2} \right] h_1 \left( -1 \right) \left( \sum_{i=1}^{n} \left( (N_i + P_i)Q_iO_iR_i + n_i b_i \right) \right)^{-2}$$

172
\[ \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} R_{i} \] \[ \ldots \quad 7.17 \]

and \[ \frac{\partial^{2} I(Q_{j})}{\partial Q_{j}^{2}} < 0 \] \[ \ldots \quad 7.18 \]

Similarly for \( j=2 \),

\[ I(Q_{2}) = \sqrt{\frac{n_{2} Q_{2}}{n_{1} Q_{1} + n_{2} Q_{2}}} \left[ \sum_{i=1}^{n} [(N_{i2} + P_{i2}) Q_{2} O_{i2} R_{2} + n_{2} b_{i2}] \right] \]

\[ \frac{\partial I(Q_{2})}{\partial Q_{2}} = \left[ \sum_{i=1}^{n} [(N_{i2} + P_{i2}) Q_{2} O_{i2} R_{2} + n_{2} b_{i2}] \right]^{-1} \]

\[ \frac{\partial^{2} I(Q_{2})}{\partial Q_{2}^{2}} = \left[ \sum_{i=1}^{n} [(N_{i2} + P_{i2}) Q_{2} O_{i2} R_{2} + n_{2} b_{i2}] \right]^{-2} \]

\[ \sum_{i=1}^{n} (N_{i2} + P_{i2}) Q_{2} O_{i2} R_{2} \] \[ \ldots \quad 7.19 \]

\[ \frac{\partial^{2} I(Q_{2})}{\partial Q_{2}^{2}} < 0 \] \[ \ldots \quad 7.20 \]

From 7.18 and 7.20, it can be observed that sufficient condition \[ \frac{\partial^{2} I(Q_{j})}{\partial Q_{j}^{2}} < 0 \] for \( j = 1, 2 \) is satisfied for achieving maximum ITOR using necessary condition \[ \frac{\partial P}{\partial Q_{j}} = 0 \] for \( j = 1, 2 \) result 7.17 and 7.19 can be rewritten as,

\[ \sqrt{\frac{n_{1} n_{2} Q_{2}}{(n_{1} Q_{1} + n_{2} Q_{2})^{2}}} \left[ \sum_{i=1}^{n} [(N_{i1} + P_{i1}) O_{i1} R_{i} + n_{1} b_{i1}] \right] = \]

\[ \sqrt{\frac{n_{1} Q_{1}}{(n_{1} Q_{1} + n_{2} Q_{2})}} \left[ \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} R_{i} \right] \]

\[ \therefore \frac{n_{2} Q_{2}}{n_{1} Q_{1} + n_{2} Q_{2}} \left[ \sum_{i=1}^{n} [(N_{i1} + P_{i1}) O_{i1} R_{i} + n_{1} b_{i1}] \right] = Q_{1} \left[ \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} R_{i} \right] \]

\[ \therefore \frac{n_{2} Q_{2} O_{i1} R_{i}}{n_{1} Q_{1} + n_{2} Q_{2}} \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} + \frac{n_{2} n_{1} Q_{2}}{n_{1} Q_{1} + n_{2} Q_{2}} \sum_{i=1}^{n} b_{i1} = Q_{1} R_{i} \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} \]
\[
\therefore \sum_{i=1}^{n_1} n_2 Q_2 \sum_{i=1}^{n_2} b_{i1} = Q_1 R_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1} \left[ 1 - \frac{n_2 Q_2}{n_1 Q_1 + n_2 Q_2} \right]
\]

\[
\therefore \sum_{i=1}^{n_1} n_2 Q_2 \sum_{i=1}^{n_2} b_{i1} = Q_1 R_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1} \left[ \frac{n_1 Q_1}{n_1 Q_1 + n_2 Q_2} \right]
\]

\[
\therefore n_2 Q_2 \sum_{i=1}^{n_1} b_{i1} = Q_1^2 R_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1}
\]

\[
\therefore Q_2 = \frac{Q_1^2 R_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1}}{n_2 \sum_{i=1}^{n_1} b_{i1}}
\]

and

\[
V h_2 \left[ \frac{n_1 n_2 Q_2}{(n_1 Q_1 + n_2 Q_2)^2} \right] \left\{ \sum_{i=1}^{n_2} (N_{i2} + P_{i2}) Q_2 O_{i3} R_2 + n_2 b_{i2} \right\} =
\]

\[
V h_2 \left[ \frac{n_2 Q_2}{(n_1 Q_1 + n_2 Q_2)} \right] \sum_{i=1}^{n_2} (N_{i2} + P_{i2}) \mathcal{O}_{i2} R_2
\]

\[
\therefore \sum_{i=1}^{n_1} n_2 Q_2 \sum_{i=1}^{n_2} b_{i2} = Q_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1} R_2
\]

\[
\therefore \sum_{i=1}^{n_1} n_2 Q_2 \sum_{i=1}^{n_2} b_{i2} = Q_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1} R_2
\]

\[
\therefore \sum_{i=1}^{n_1} n_2 Q_2 \sum_{i=1}^{n_2} b_{i2} = Q_2 R_1 \left[ 1 - \frac{n_1 Q_1}{n_1 Q_1 + n_2 Q_2} \right] \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1}
\]

\[
\therefore n_2 Q_2 \sum_{i=1}^{n_1} b_{i2} = Q_2 R_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1}
\]

\[
\therefore n_1 Q_1 \sum_{i=1}^{n_1} b_{i2} = Q_2^2 R_1 \sum_{i=1}^{n_1} (N_{i1} + P_{i1}) \mathcal{O}_{i1} \left[ \frac{n_1 Q_1}{n_2 \sum_{i=1}^{n_1} b_{i1}} \right] R_2 \sum_{i=1}^{n_2} (N_{i2} + P_{i2}) \mathcal{O}_{i2}
\]

Form results 7.22 and 7.23, we have,
\[ n_1 Q_1 \sum_{i=1}^{n} b_{1i} = \frac{Q_1 R_1}{R_2} \left[ \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} \right] \cdot R_2 \sum_{i=1}^{n} (N_{i2} + P_{i2}) O_{i2} \]

\[ n_2 \left( \sum_{i=1}^{n} b_{1i} \right)^2 \]

\[ Q_1 = \frac{n_1 n_2 \left( \sum_{i=1}^{n} b_{1i} \right)^2 \left( \sum_{i=1}^{n} b_{2i} \right)}{R_1 R_2 \left[ \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} \right] \left( \sum_{i=1}^{n} (N_{i2} + P_{i2}) O_{i2} \right)^2} \]

\[ Q_{opt} = \left\{ \frac{n_1 n_2 \left( \sum_{i=1}^{n} b_{1i} \right)^2 \left( \sum_{i=1}^{n} b_{2i} \right)}{R_1 R_2 \left[ \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} \right] \left( \sum_{i=1}^{n} (N_{i2} + P_{i2}) O_{i2} \right)^2} \right\}^{1/2} \]

\[ \cdot \quad \text{...... 7.22} \]

and from result 7.21 and 7.23,

\[ Q_{opt} = \left\{ \frac{n_1 n_2 \left( \sum_{i=1}^{n} b_{1i} \right)^2 \left( \sum_{i=1}^{n} b_{2i} \right)}{R_1 R_2 \left[ \sum_{i=1}^{n} (N_{i1} + P_{i1}) O_{i1} \right] \left( \sum_{i=1}^{n} (N_{i2} + P_{i2}) O_{i2} \right)^2} \right\}^{1/2} \]

\[ \cdot \quad \text{...... 7.23} \]

\[ T \left( Q_{opt} \right) = \sum_{i=1}^{n} \left( N_{i1} + P_{i1} \right) Q_{opt} + n_1 b_{1i} \quad \text{for } j=1,2 \quad \text{...... 7.24} \]

\[ I \left( Q_{opt} \right) = V \left[ \frac{n_1 Q_{opt} + n_2 Q_{opt}}{n_1 Q_{opt} + n_2 Q_{opt}} \right] h_j \quad \text{for } j=1,2 \quad \text{...... 7.25} \]

7.3.4. Hypothetical Problem:

Let us suppose that any two brands called I and II are competing in the market in which total anticipated sales of product is fixed and is 1000 units, i.e. \( V = 1000 \) units. Other information regarding the problem is as follows:
<table>
<thead>
<tr>
<th>Brand</th>
<th>Total No. of runs of quantity produce</th>
<th>Logistic margin (Rs/Unit)</th>
<th>$R_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5</td>
<td>3.00</td>
<td>0.001</td>
</tr>
<tr>
<td>II</td>
<td>6</td>
<td>2.50</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**For Brand-I:**

<table>
<thead>
<tr>
<th>Operation i</th>
<th>Labour Rate for setup (in Rs. Per order) $L_i$</th>
<th>Setup time (in hours) $S_i$</th>
<th>Material cost (per setup) $M_i$</th>
<th>Lots in queue $N_i$</th>
<th>Lots in process $P_i$</th>
<th>Value of Parts (in Rs.) $O_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.50</td>
<td>0.50</td>
<td>0.30</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>8.50</td>
<td>0.35</td>
<td>0.00</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>8.50</td>
<td>0.20</td>
<td>0.00</td>
<td>2</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>6.20</td>
<td>0.45</td>
<td>0.90</td>
<td>2</td>
<td>2</td>
<td>14</td>
</tr>
</tbody>
</table>

**For Brand-II:**

<table>
<thead>
<tr>
<th>Operation i</th>
<th>Labour Rate for setup (in Rs. Per order) $L_i$</th>
<th>Setup time (in hours) $S_i$</th>
<th>Material cost (per setup) $M_i$</th>
<th>Lots in queue $N_i$</th>
<th>Lots in process $P_i$</th>
<th>Value of Parts (in Rs.) $O_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.60</td>
<td>0.47</td>
<td>0.35</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>9.20</td>
<td>0.38</td>
<td>0.10</td>
<td>2</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>7.50</td>
<td>0.25</td>
<td>0.05</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>5.50</td>
<td>0.40</td>
<td>0.80</td>
<td>2</td>
<td>2</td>
<td>15</td>
</tr>
</tbody>
</table>

Solution of the problem is as bellow:

Chapter 7: Model 2: Problem Formulation

<table>
<thead>
<tr>
<th>Brand Demand (Units)</th>
<th>Optimal Total Turnover (Units)</th>
<th>Optimal Inventory Turnover</th>
<th>Optimal Cost</th>
<th>Optimal Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2527</td>
<td>505</td>
<td>140.86</td>
<td>10.14</td>
</tr>
<tr>
<td>II</td>
<td>2780</td>
<td>463</td>
<td>161.71</td>
<td>8.10</td>
</tr>
</tbody>
</table>

7.3.5. Remarks:-

Higher inventory turnover ratio reflects the good inventory management of the firm in the competitive market. Product requiring
multiple serial operations under duopolistic situation it is clear from the solution of the hypothetical problem stated above that ITOR of brand-I is grater than its rival brand-II which justifies that inventory management brand-I is more efficient than rivalry brand.

7.4. Conclusion:
In competitive markets we always seen that there are healthy or unhealthy competition between two or more brands produced with the help of single or multiple operations. Inventory turnover ratio suggest clear eye site to the financial management to handle stock in hand under condition stated above. It is also justified from the results obtained of the hypothetical problem stated in this chapter.