Defective and Repairable Items Unsteady Deterioration Rate Inventory Model Under Three Tired Prices and Time Dependent Demand
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Abstract

Lot received or units produced are not all perfect items. A time and price dependent demand inventory model is formulated when items produced or lot received are of defective and repairable nature. Three tired pricing is considered. For different situations, expression for total profit is derived to derive optimal solution. For parameter, post-optimality computations are also done.

Keywords: Inventory model, Varying deterioration, Price dependent demand, Time dependent demand, Three tire pricing, Defective items, Repairable items, Time varying holding cost.

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INTRODUCTION

Everywhere inventories are essential. Absence of inventory make customer uncomfortable and it may affect goodwill or profit of future of the organization. Also certain items are such that their value reduces during their storage period and we say these items as deteriorating items. In last few decays much attention has been given towards developing decaying items models. A stock model under fixed deterioration rate was proposed by Ghare and Schrader [1963]. Subsequently, taking into account changeable deterioration rate, model was expanded by Covert and Philip [1973]. Under selling price dependent demand and Weibull decay rate, Aggarwal and Goel [1984] obtained an inventory model. Mukhopadhyay et al. [2004] obtained a stock model for decaying items under price dependent demand. A stock with selling price related inventory model for decaying units was formulated by Teng and Chang [2005]. Under changeable storage cost and stock dependent demand, a stock model was constructed by Alfares [2007]. A time and selling price dependent inventory model was obtained by Mathew [2013]. A stock level model under stock size and price fluctuating demand with varying deterioration was constructed by Patel and Sheikh [2015]. Under trade credit situation for non-instantaneous deteriorating items, a stock level model was formulated by Tsao et al. [2017].

Imperfect quality of goods affects management of inventory. Therefore this characteristic is to be taken into consideration. Several academicians studied and analysed difficulties associated with defective production process of an item. Lee and Rosenblatt [1985] proposed an imperfect quality items stock model for obtaining optimal order policy. An EOQ model that contains known proportion of defective units in received lot and to remove these items costs incurs of fixed and variable inspection nature was obtained by Schwaller [1988]. When production process is not perfect, an inventory model was formulated by Cheng [1991]. It was assumed that demand of item depends on unit production cost. An inventory model when received items are not 100% perfect was obtained by Salameh and Jaber [2000]. Imperfect units are separated after 100% screening and their selling will be done at discounted price. An EPQ model under known proportion of defective units in lot produced following a uniform distribution was obtained by Hayek and Salameh [2001]. A defective items production inventory model was obtained by Goyal and Barron [2002]. A no shortage defective items inventory model was constructed by Papachristos and Konstantaras [2006] in which at cycle end defective units has been removed. Under effect of learning, an EPQ model having defective units was obtained by Jaber et al. [2008]. Under stock out situation, Hsu and Hsu [2012] obtained a defective units stock model. An EPQ with rework to determine selling price, stock size and shipment size collectively was formulated by Taleizadeh et al. [2015]. A deteriorating items production inventory model for defective items was

considered by Shukla et al. [2016]. Naik and Patel [2017] constructed a time and price related stock model for defective units under unsteady deterioration.

The term repairing/reamanufacturing in inventory modelling was first introduced by Schrady [1967]. By considering multi-item system sharing the same repair facility and stock-out service level constraints, Mabini et al. [1992] expanded the model. A linear demand inventory model for defective items in which some items can be repairable, was considered by Yadav and Kumar [2014]. Gothi et al. [2017] formulated a linear demand and exponential type deterioration of items inventory model in which received items having defects but some of them can be repairable. Naik and Patel [2018] constructed a price and time dependent demand stock model for defective and repairable items under unsteady deterioration.

A varying deterioration inventory model for defective and repairable items is developed. Three tire pricing policy is adopted. Three tire price and time related demand function is considered. Stock outs are not permitted. Model is justified with numerical example and post-optimality computations.

ASSUMPTIONS AND NOTATIONS

NOTATIONS

Notations used in modelare

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(p_i,t)</td>
<td>Price and time dependent demand (a_i+b_i t-p_i p_i), a&gt;0, 0&lt;b_i&lt;1, p_i&gt;0, i=1,2,3 in different intervals</td>
</tr>
<tr>
<td>c</td>
<td>Unit cost of purchasing of item</td>
</tr>
<tr>
<td>p_i</td>
<td>Selling price per unit of item in different intervals in a cycle</td>
</tr>
<tr>
<td>d_i</td>
<td>Imperfect articles (%)</td>
</tr>
<tr>
<td>1-d</td>
<td>% of perfect articles</td>
</tr>
<tr>
<td>d_1</td>
<td>Items for repair (in %)</td>
</tr>
<tr>
<td>d_2</td>
<td>% of perfect articles</td>
</tr>
<tr>
<td>d_3</td>
<td>Items for repair (in %)</td>
</tr>
<tr>
<td>λ</td>
<td>Rate of screening</td>
</tr>
<tr>
<td>SR</td>
<td>Revenue from sales</td>
</tr>
<tr>
<td>A</td>
<td>Per order cost of replenishment</td>
</tr>
<tr>
<td>z</td>
<td>Screening cost of one item</td>
</tr>
<tr>
<td>p_d</td>
<td>Selling value of imperfect quality units</td>
</tr>
<tr>
<td>h(t)</td>
<td>Storage cost of item (x+y t, x&gt;0, 0&lt;y&lt;1)</td>
</tr>
<tr>
<td>m</td>
<td>Per unit cost of transportation of repairable items</td>
</tr>
<tr>
<td>µ_1</td>
<td>Period of screening</td>
</tr>
<tr>
<td>T</td>
<td>Inventory cycle time</td>
</tr>
<tr>
<td>I(t)</td>
<td>At time t, inventory size</td>
</tr>
<tr>
<td>Q</td>
<td>Quantity required in a cycle</td>
</tr>
<tr>
<td>θ_1</td>
<td>Rate of deterioration in t_1 ≤ t ≤ t_2, 0 &lt; θ &lt; 1</td>
</tr>
<tr>
<td>θ_2</td>
<td>Rate of deterioration in t_2 ≤ t ≤ T, 0 &lt; θ &lt; 1</td>
</tr>
<tr>
<td>π</td>
<td>Items per unit profit</td>
</tr>
</tbody>
</table>

ASSUMPTIONS

Model is based on assumptions

- Demand of item is function of time and prices.
- Product has infinite and instantaneous replenishment rate.
- There is zero lead time.
- There are no shortages of items.
- During screening process, demand occurs but is less than screening rate (λ) i.e. (a_i+b_i t-p_i p_i) < λ.
- Deterioration of items and defective items are independent.
- Some defective items are repairable items.
- In each cycle, no repairing or replacement of deteriorated items.
- Only one item is taken for analysis.
- Varying holding cost is considered.
- Screening machine takes very less time for inspection of items for verification means we say that screening rate (λ) is sufficiently large.

THE MATHEMATICAL MODEL AND ANALYSIS

Items of amount Q are received at the starting of cycle. Out of Q units d% of items are defective items and out of these defective items, repairable items are d_1%. These units, at rate of λ per unit time as shown in figure below go through screening process during time 0 to µ_1. Items which are found to be perfect are separated and demand occurred during 0 to µ_1 will be fulfilled from these perfect quality items. Moreover from these defective items repairable items are separated and sent for repairing to manufacturer and remaining non-repairable units are sold at end of cycle at reduced price as a single batch. One cycle time is divided as (0, t_1), (t_1, t_2) and (t_2, T). In period (0, t_1) there is no deterioration and price is p_1, in period (t_1, t_2) deterioration rate is θ and price is p_2, in period (t_2,T) deterioration rate is θt and price is p_3, (where p_1 > p_2 > p_3). At end of a cycle because of deterioration and demand, level of inventory reaches to zero.

Here \[ \mu_1 = \frac{Q}{\lambda} \] (1)

And we put restriction for defective percentage (d) as:

\[ d \leq 1 - \frac{(a_i+b_i t-p_i p_i)}{\lambda} \] (2)

During cycle time (0 ≤ t ≤ T) inventory size is as shown below:

![Fig-1](image-url)
For period \((0,T)\), differential equations considered are:

\[
\frac{dI(t)}{dt} = -(a + b_t - \rho_p) \quad 0 \leq t \leq t_1
\]  
(3)

\[
\frac{dI(t)}{dt} + \theta I(t) = -(a + b_t - \rho_p) \quad t_1 \leq t \leq t_2
\]  
(4)

\[
\frac{dI(t)}{dt} + \theta t I(t) = -(a + b_t - \rho_p) \quad t_2 \leq t \leq T
\]  
(5)

conditions initially taken as: \(I(0) = Q, \ I(t_1) = S_1, \ I(T) = 0\).

Respective solutions are:

\[
I(t) = Q - (a t - \rho_p t + b t) + \frac{1}{2} b_t t^2
\]  
(6)

\[
\begin{align*}
I(t) &= a_t (t_1 - t) p_2 (t_1 - t) + \frac{1}{2} a_t \theta t_1^2 (t_1 - t)^2 + \frac{1}{2} b_t (t_1 - t) + \frac{3}{2} b_t \theta (t_1 - t)^2 \\
&\quad + S_1 \left[ 1 + \theta (t_1 - t) \right]
\end{align*}
\]  
(7)

\[
\begin{align*}
I(t) &= a_t (T - t) p_2 (T - t) + \frac{1}{2} b_t (T - t) + \frac{1}{6} a_t \theta (T - t)^3 + \frac{1}{2} b_t \theta (T - t)^2 - \frac{1}{4} b_t \theta^2 (T - t)^2 \\
&\quad + dQ
\end{align*}
\]  
(8)

(Higher powers of \(\theta\) are not considered)

\(dQ\) is defective items separated at time \(\mu_1\) after screening process.

Therefore between \(\mu_1 \leq t \leq T\), effective inventory is:

\[
I_1(t) = Q (1-d) - (a_t p_2 t + \frac{1}{2} b_t t^2)
\]  
(9)

Substituting \(t = t_1\) in (6) gives

\[
Q = S_1 + \left[ a_t t_1 p_2 t_1 + \frac{1}{2} b_t t_1^2 \right]
\]  
(10)

Under the assumption that for repairing, completion of cycle, are sold at original price. For repairable items of amount \(d_1\%\) sent to manufacturer and before completion of cycle \(t_2 \leq t \leq T\), we receive back items after repairing. These repaired items before sending to manufacturer and receiving back items repaired causes transportation cost. Level of stock during \(t_2 \leq t \leq T\) is as below:

\[
I_r(t) = a_t (T - t) p_2 (T - t) + \frac{1}{2} b_t (T - t) + \frac{1}{6} a_t \theta (T - t)^3 - \frac{1}{6} p_2 \theta (T - t)^2 + \frac{1}{8} b_t \theta (T - t)^2
\]  
(11)

Taking \(t = t_2\) in equations (7) and (11), we get
We get from equations (12) and (13)

\[
S = \left[ \frac{1}{I(t)} + 10(t, t_1) - d_i \right]
\]

(14)

We get equation (10) by substituting value of \( S_i \) from equation (14)

\[
Q = \left[ \frac{1}{I(t)} + 10(t, t_1) - d_i \right]
\]

(15)

Using (15) in (6), gives
\[ I(t) = \frac{1}{1 + 0(t, -t) - d} \]

\[ \begin{align*}
& a_{1}(T_{t^{*}}) \cdot p_{p}(T_{t^{*}}) + \frac{1}{2} b_{2}(T^{*}t^{*}) + \frac{7}{6} a_{0}(T^{*}t^{*}) - \frac{1}{6} p_{p} \cdot 0(T^{*}t^{*}) + \frac{1}{8} b_{2} 0(T^{*}t^{*}) \\
& \frac{1}{2} a_{1}(T_{t^{*}}) - p_{p} \cdot 0(T_{t^{*}}) + \frac{1}{2} b_{2} 0(T_{t^{*}}) \\
& \frac{1}{4} b_{2} 0(T^{*}t^{*}) \cdot a_{1}(t_{t^{*}} - t_{t^{*}}) + p_{p} \cdot p_{p}(t_{t^{*}} - t_{t^{*}}) \\
& \frac{1}{2} a_{0}(t_{t^{*}}) + \frac{1}{2} p_{p} \cdot 0(t_{t^{*}}) - \frac{1}{2} b_{2} 0(t_{t^{*}}) \\
& \frac{1}{3} b_{2} 0(t_{t^{*}}) + a_{1}(t_{t^{*}} - t_{t^{*}}) + p_{p} \cdot p_{p}(t_{t^{*}} - t_{t^{*}}) \\
& + \left( a_{0}(t_{t^{*}}) + p_{p}p_{p}(t_{t^{*}}) + \frac{1}{2} b_{2} 0(t_{t^{*}}) \right)
\end{align*} \] 

Substituting (15) in (9) gives

\[ I(t) = \frac{(1 - d)}{1 + 0(t, -t) - d} \]

\[ \begin{align*}
& a_{1}(T_{t^{*}}) \cdot p_{p}(T_{t^{*}}) + \frac{1}{2} b_{2}(T^{*}t^{*}) + \frac{7}{6} a_{0}(T^{*}t^{*}) - \frac{1}{6} p_{p} \cdot 0(T^{*}t^{*}) + \frac{1}{8} b_{2} 0(T^{*}t^{*}) \\
& \frac{1}{2} a_{1}(T_{t^{*}}) - p_{p} \cdot 0(T_{t^{*}}) + \frac{1}{2} b_{2} 0(T_{t^{*}}) \\
& \frac{1}{4} b_{2} 0(T^{*}t^{*}) \cdot a_{1}(t_{t^{*}} - t_{t^{*}}) + p_{p} \cdot p_{p}(t_{t^{*}} - t_{t^{*}}) \\
& + \frac{1}{2} a_{0}(t_{t^{*}}) + \frac{1}{2} p_{p} \cdot 0(t_{t^{*}}) - \frac{1}{2} b_{2} 0(t_{t^{*}}) \\
& \frac{1}{3} b_{2} 0(t_{t^{*}}) + a_{1}(t_{t^{*}} - t_{t^{*}}) + p_{p} \cdot p_{p}(t_{t^{*}} - t_{t^{*}}) \\
& + d \left( a_{0}(t_{t^{*}}) + p_{p}p_{p}(t_{t^{*}}) + \frac{1}{2} b_{2} 0(t_{t^{*}}) \right)
\end{align*} \] 

We get equation (7) by substituting value of \( S_{1} \) from equation (13)

\[ I(t) = \frac{1 + 0(t, -t)}{1 + 0(t, -t) - d} \]

\[ \begin{align*}
& a_{1}(T_{t^{*}}) \cdot p_{p}(T_{t^{*}}) + \frac{1}{2} b_{2}(T^{*}t^{*}) + \frac{7}{6} a_{0}(T^{*}t^{*}) - \frac{1}{6} p_{p} \cdot 0(T^{*}t^{*}) + \frac{1}{8} b_{2} 0(T^{*}t^{*}) \\
& \frac{1}{2} a_{1}(T_{t^{*}}) - p_{p} \cdot 0(T_{t^{*}}) + \frac{1}{2} b_{2} 0(T_{t^{*}}) \\
& \frac{1}{4} b_{2} 0(T^{*}t^{*}) \cdot a_{1}(t_{t^{*}} - t_{t^{*}}) + p_{p} \cdot p_{p}(t_{t^{*}} - t_{t^{*}}) \\
& + \frac{1}{2} a_{0}(t_{t^{*}}) + \frac{1}{2} p_{p} \cdot 0(t_{t^{*}}) - \frac{1}{2} b_{2} 0(t_{t^{*}}) \\
& \frac{1}{3} b_{2} 0(t_{t^{*}}) + a_{1}(t_{t^{*}} - t_{t^{*}}) + p_{p} \cdot p_{p}(t_{t^{*}} - t_{t^{*}}) \\
& + d \left( a_{0}(t_{t^{*}}) + p_{p}p_{p}(t_{t^{*}}) + \frac{1}{2} b_{2} 0(t_{t^{*}}) \right)
\end{align*} \] 

(16)

(17)

(18)
Total profit ($\pi$) consists of:

(i) Cost of ordering (OC) = $A$ \hspace{1cm} (19)

(ii) Cost of screening (SrC) = $zQ$ \hspace{1cm} (20)

(iii) Transportation cost (TC) = $mdQ$ \hspace{1cm} (21)

(iv) $HC = \int_0^T (x + yt) I(t) \, dt$

\hspace{1cm} = \int_0^n (x + yt) I_1(t) \, dt + \int_{t_1}^n (x + yt) I_2(t) \, dt + \int_{t_1}^T (x + yt) I_3(t) \, dt \hspace{1cm} (22)

(v) $DC = c_1 \int_{t_1}^T I_1(t) \, dt + c_2 \int_{t_1}^T I_2(t) \, dt \hspace{1cm} (23)$

(vi) $SR = Revenue \, generated \, during \, the \, cycle$

+ Revenue from imperfect quality items

+ Revenue from repaired items

\hspace{1cm} = \int_{t_1}^T (a_1 + b_1 t - \rho_1 p_1) I(t) \, dt \hspace{1cm} (24)

(by not considering higher powers of $\theta$)

\hspace{1cm} $\pi = \frac{1}{T} \left[ SR - OC - SrC - TC - HC - DC \right]$ \hspace{1cm} (25)

Putting value in equation (25) from equations (19) to (24) provides overall unit profit. Moreover, it can be obtained in terms of $p_1$, $p_2$, $p_3$ and $T$ using $t_1 = v_1 T$, $t_2 = v_2 T$ in (25). Taking derivative with respect to $p_1$, $p_2$, $p_3$, $T$ and equating it to zero, in equation (25), gives

$\frac{\partial \pi}{\partial p_1} = 0, \frac{\partial \pi}{\partial p_2} = 0, \frac{\partial \pi}{\partial p_3} = 0, \frac{\partial \pi}{\partial T} = 0, \hspace{1cm} (26)$

Moreover it has to satisfy the condition

\[
\begin{vmatrix}
\frac{\partial^2 \pi}{\partial p_1^2} & \frac{\partial^2 \pi}{\partial p_1 \partial p_2} & \frac{\partial^2 \pi}{\partial p_1 \partial p_3} & \\
\frac{\partial^2 \pi}{\partial p_2 \partial p_1} & \frac{\partial^2 \pi}{\partial p_2^2} & \frac{\partial^2 \pi}{\partial p_2 \partial p_3} & \\
\frac{\partial^2 \pi}{\partial p_3 \partial p_1} & \frac{\partial^2 \pi}{\partial p_3 \partial p_2} & \frac{\partial^2 \pi}{\partial p_3^2} & \\
\frac{\partial^2 \pi}{\partial T \partial p_1} & \frac{\partial^2 \pi}{\partial T \partial p_2} & \frac{\partial^2 \pi}{\partial T \partial p_3} & \frac{\partial^2 \pi}{\partial T^2}
\end{vmatrix} > 0, \hspace{1cm} (27)
\]

**NUMERICAL EXAMPLE**

Considering $A= Rs.100$, $a_1=500$, $a_2=490$, $a_3=480$, $b_1=0.04$, $b_2=0.05$, $b_3=0.06$, $c=25$, $d_1=15$, $d = 0.05$, $d_1 = 0.03$, $z = 0.40$, $m = 70$, $0 = 0.05$, $x = 5$, $y = 0.05$, $p_1=4$, $p_2=4.5$, $p_3=5$, $v_1 = 0.30$, $v_2 = 0.50$, in suitable units. Optimal values are: $p_1^* = 62.4150$, $p_2^* = 56.6567$, $p_3^* = 50.5989$, $T^* = 0.3921$, $Profit^* = 11750.6414$ and $Q^* = 92.6572$. Equation (27) is also satisfied. Graphs for prices and profit are also shown below.
POST-OPTIMALITY ANALYSIS

Study of one parameter at a time, table below gives post-optimality computations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>%</th>
<th>T</th>
<th>$p_1$</th>
<th>$p_2$</th>
<th>$p_3$</th>
<th>Profit</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>a&lt;sub&gt;1&lt;/sub&gt;</td>
<td>+20%</td>
<td>0.3886</td>
<td>74.9173</td>
<td>56.7822</td>
<td>50.7212</td>
<td>13690.0944</td>
<td>97.4917</td>
</tr>
<tr>
<td></td>
<td>+10%</td>
<td>0.3903</td>
<td>68.6661</td>
<td>56.7195</td>
<td>50.6600</td>
<td>12674.4407</td>
<td>95.0750</td>
</tr>
<tr>
<td></td>
<td>-10%</td>
<td>0.3938</td>
<td>56.1638</td>
<td>56.5940</td>
<td>50.5378</td>
<td>10918.6967</td>
<td>90.1902</td>
</tr>
<tr>
<td></td>
<td>-20%</td>
<td>0.3956</td>
<td>49.9126</td>
<td>56.5314</td>
<td>50.4767</td>
<td>10178.6067</td>
<td>87.7206</td>
</tr>
<tr>
<td></td>
<td>+20%</td>
<td>0.3857</td>
<td>62.3259</td>
<td>67.5378</td>
<td>50.5845</td>
<td>12881.2137</td>
<td>94.9846</td>
</tr>
<tr>
<td></td>
<td>+10%</td>
<td>0.3889</td>
<td>62.3704</td>
<td>62.0972</td>
<td>50.5916</td>
<td>12289.2306</td>
<td>93.8370</td>
</tr>
<tr>
<td></td>
<td>-10%</td>
<td>0.3954</td>
<td>62.4595</td>
<td>51.2163</td>
<td>50.6060</td>
<td>11265.4469</td>
<td>91.4686</td>
</tr>
<tr>
<td></td>
<td>-20%</td>
<td>0.3988</td>
<td>62.5042</td>
<td>45.7760</td>
<td>50.6139</td>
<td>10833.6480</td>
<td>90.2695</td>
</tr>
<tr>
<td>a&lt;sub&gt;2&lt;/sub&gt;</td>
<td>+20%</td>
<td>0.3647</td>
<td>62.1906</td>
<td>56.6243</td>
<td>60.1384</td>
<td>14161.9612</td>
<td>95.1199</td>
</tr>
<tr>
<td></td>
<td>+10%</td>
<td>0.3776</td>
<td>62.3024</td>
<td>56.6397</td>
<td>55.3670</td>
<td>12898.3408</td>
<td>93.8598</td>
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<tr>
<td></td>
<td>-10%</td>
<td>0.4083</td>
<td>62.5284</td>
<td>56.6758</td>
<td>45.8347</td>
<td>10718.9489</td>
<td>91.4739</td>
</tr>
<tr>
<td></td>
<td>-20%</td>
<td>0.4269</td>
<td>62.6430</td>
<td>56.6974</td>
<td>41.0754</td>
<td>9803.3686</td>
<td>90.3936</td>
</tr>
<tr>
<td>a&lt;sub&gt;3&lt;/sub&gt;</td>
<td>+20%</td>
<td>0.3613</td>
<td>62.4350</td>
<td>56.6969</td>
<td>50.6710</td>
<td>11706.2453</td>
<td>85.2680</td>
</tr>
<tr>
<td></td>
<td>+10%</td>
<td>0.3757</td>
<td>62.4252</td>
<td>56.6773</td>
<td>50.6357</td>
<td>11727.9807</td>
<td>88.7222</td>
</tr>
<tr>
<td></td>
<td>-10%</td>
<td>0.4107</td>
<td>62.4041</td>
<td>56.6352</td>
<td>50.5604</td>
<td>11774.3537</td>
<td>97.1223</td>
</tr>
<tr>
<td></td>
<td>-20%</td>
<td>0.4323</td>
<td>62.3926</td>
<td>56.6125</td>
<td>50.5200</td>
<td>11799.2753</td>
<td>102.3096</td>
</tr>
<tr>
<td>x</td>
<td>+20%</td>
<td>0.3904</td>
<td>62.4134</td>
<td>56.6609</td>
<td>50.6045</td>
<td>11747.9225</td>
<td>92.3013</td>
</tr>
<tr>
<td></td>
<td>+10%</td>
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Calculations of Table 1 shows that increase or decrease in value of profit and order quantity occur, when parameters 'a<sub>1</sub>', 'a<sub>2</sub>', 'a<sub>3</sub>' increase/decrease.

Also when parameters ‘θ’ and ‘x’ increase/decrease then total profit and order quantity decrease/increase. Moreover, when increase/decrease in parameters ‘A’ and ‘$p_1$’ occurs, then profit also shows decrease/increase and order quantity shows increase/decrease. Also when parameters ‘$p_2$’ and ‘$p_3$’ increase/decrease then profit and order quantity decrease/increase.

**SPECIAL CASE**
Taking $d=0$, $d_1=0$, $p_2=0$, $z=0$, $m=0$ gives
$T^* =0.3908$, $p_1^* = 62.6469$, $p_2^* = 54.8515$, $p_3^* = 48.8029$, Profit*$=Rs. 12606.6509.
The result corresponds with result obtained by Patel and Patel [2021].

**CONCLUSION**
Price and time dependent demand for imperfect quality and repairable items under three tire pricing inventory model is developed. For major parameters, post-optimality analysis is done. There will be variations in profit and order quantity with variations in parameter values.

**REFERENCES**