A Realibility Model of Two-Unit Non-identical Cold Standby System under the Influence of Snow Storm Causing Rescue Operation

Narender Singh¹, Dalip Singh², Sheetal³

¹Govt. College Birohar (Jhajjar) -124106, Haryana, India.
²,³Department of Mathematics, M.D. University, Rohtak-124001, Haryana, India.

(*corresponding author)

Abstract

This paper, presents mathematical model to predict two unit non-identical cold standby system under snowstorm as abnormal weather conditions. Failed unit cannot be possible to make operative directly, so after snowstorm is over, rescue operation starts first digging out start after complete the digging out snow removing starts and then hospitalization of the system starts as repair. Failure rates of system due to snowstorm as constant while repair time distribution are general. Semi-Markov process and the technique of regenerative point are applied to get mean time to system failure and others reliability characteristics.

Keywords: Non-identical cold stand by system, rescue operation, snow removing, hospitalization.

INTRODUCTION

In literature, various researchers have discussed the concepts of reliability modeling of standby systems including [1-4]. Wang 2009 [5] and Wang 2012 [6] describes comparative analysis of the availability between systems. Yusuf 2015 studied modeling and availability and assessment of a reliable system subject to slight deterioration in case of imperfect repairs[7].

The climate has a major impact on system performance. It is said that the climatic conditions that have a great effect on the system component are abnormal meteorological conditions, just like as high snow, high temperatures, dust storm, thunderstorms, heavy rainfall. Connections can be distributed in anomalous weather conditions when television antennas, etc. storms The study of the effects of climate on systems had aroused the curiosity of several researchers depend upon the reliability, among which Goel et al. [8], Gupta and Goel [9] and Goel, Kumar and Rastogi [10] have explained reliability measures of systems with various weather conditions. Nailwal and Singh [12] analyzed reliability and sensitivity in different weather conditions. Sheetal, Singh and Taneja[13] studied reliability and profit of a system effect of temperature on operation.

Singh ,N. et al. [11] discuss the paper for identical system in snowstorms as abnormal weather conditions. Taking into account the facts and situations of paper [11] in this paper we consider the snowstorms as a abnormal weather condition for two unit non-identical cold standby system. Failed unit cannot be possible to make operative directly, so after snowstorm is over, rescue operation starts first digging out start after complete the digging out snow removing starts and then hospitalization of the system starts as repair. Mean time to system failure, availability analysis, busy period analysis of rescue team during digging out, snow removing and hospitalization and profit analysis are computed.

The following are the assumption for the model:

- Non-identical units are considered
- cold stand by system
- the unit of the system fail due to snow storm
- first the failed unit digging out from snow storm after the excavation snow removing starts after then hospitalization for repairs
- the unit becomes operative after complete the hospitalization
2. NOTATIONS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>$\lambda$</td>
<td>Failure rate of operative unit due to snow storm</td>
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<tr>
<td>$G_i(t)$, $G_i(t)$, $g_i(t)$, $g_i(t)$</td>
<td>Cumulative density function and probability density function of the rate of digging out, snow removing and hospitalization time of first failed unit respectively.</td>
</tr>
<tr>
<td>$G_i(t)$, $G_i(t)$, $g_i(t)$, $g_i(t)$</td>
<td>Cumulative density function and probability density function of the rate of digging out, snow removing and hospitalization time of second failed unit respectively.</td>
</tr>
</tbody>
</table>

**GOOD STATE** □ **FAILED STATE** ★ **REGENERATIVE POINT**

**Figure 1.** State Transition Diagram
Transition Probabilities :-

In the figure 1. states 4, 8, 10, 11, 15 and 18 are non-regenerative and remaining others are regenerative states.

\[ dQ_{01}(t) = \lambda_1 e^{-\lambda_2 t}dt \]
\[ dQ_{12}(t) = e^{-\lambda_2 t} g_1(t)dt \]
\[ dQ_{14}(t) = \lambda_2 e^{-\lambda_2 t} G_2(t)dt \]
\[ dQ_{15}(t) = (\lambda_2 e^{-\lambda_2 t} \odot 1)g_1(t)dt \]
\[ dQ_{23}(t) = e^{-\lambda_2 t} g_2(t)dt \]
\[ dQ_{29}(t) = \lambda_2 e^{-\lambda_2 t} g_2(t)dt \]
\[ dQ_{30}(t) = e^{-\lambda_2 t} g_3(t)dt \]
\[ dQ_{310}(t) = \lambda_2 e^{-\lambda_2 t} G_3(t)dt \]
\[ dQ_{317}(t) = e^{-\lambda_2 t} g_3(t)dt \]
\[ dQ_{3123}(t) = g_3(t)dt \]
\[ dQ_{1231}(t) = g_6(t)dt \]
\[ dQ_{1417}(t) = e^{-\lambda_1 t} g_5(t)dt \]
\[ dQ_{1416}(t) = (\lambda_1 e^{-\lambda_1 t} \odot 1)g_5(t)dt \]
\[ dQ_{1616}(t) = g_6(t)dt \]
\[ dQ_{170}(t) = e^{-\lambda_1 t} g_5(t)dt \]
\[ dQ_{181}(t) = (\lambda_1 e^{-\lambda_1 t} \odot 1)g_6(t)dt \]

Taking Laplace Stieltjes Transformation we get

\[ p_{ij} = \lim_{t \to 0^+} Q_{ij}(t) = \lim_{s \to 0} Q_{ij}^{(s)}(s) \]

\[ p_{01} = 1 \]
\[ p_{12} = g_2(\lambda_2), p_{14} = (1 - g_1(\lambda_2)), p_{15}^4 = (1 - g_1(\lambda_2)) \]
\[ p_{23} = g_2(\lambda_2), p_{28} = (1 - g_2(\lambda_2)), p_{29}^8 = (1 - g_2(\lambda_2)) \]
\[ p_{30} = g_3(\lambda_2), p_{310} = (1 - g_3(\lambda_2)), p_{32}^{10} = (1 - g_3(\lambda_2)) \]
\[ p_{56} = g_6(0) = 1 \]
\[ p_{67} = g_6(0) = 1 \]
\[ p_{714} = g_6(\lambda_1), p_{124}^{12} = (1 - g_3(\lambda_1)) \]
\[ p_{97} = g_5(0) = 1, p_{1213} = g_5(0) = 1, p_{131} = g_6(0) = 1 \]
\[ p_{1417} = g_5(\lambda_1), p_{1416}^{15} = (1 - g_5(\lambda_1)), p_{161} = g_6(0) = 1 \]
\[ p_{170} = g_6(\lambda_1), p_{127}^{18} = (1 - g_5(\lambda_1)) \]

By these transition probabilities, it can be verified that

\[ p_{01} = 1 \]
\[ p_{12} + p_{15}^{(4)} = p_{12} + p_{14} = 1 \]
\[ p_{23} + p_{26}^{(7)} = p_{23} + p_{27} = 1 \]
\[ p_{30} + p_{37}^{(10)} = p_{30} + p_{310} = 1 \]
\[ p_{47} = 1 = p_{56} = p_{91} = p_{1213} = p_{131} = p_{161} \]
\[ p_{714} + p_{712}^{(11)} = p_{714} + p_{1416}^{(15)} = p_{170} + p_{171}^{(18)} = 1 \]
\[ \mu_i \] is the mean sojourn time at the regenerative state ‘i’ then mathematically is defined as

\[ \mu_i = E(T) = Pr(T > t) \]
\[ \mu_0 = \frac{1}{\lambda_1} \]
\[ \mu_1 = \frac{1}{\lambda_2} (1 - g_1(\lambda_2)) \]
\[ \mu_2 = \frac{1}{\lambda_2} (1 - g_2(\lambda_2)) \]
\[ \mu_3 = \frac{1}{\lambda_2} (1 - g_3(\lambda_2)) \]
\[ \mu_5 = -g_2(\lambda_5), \mu_6 = -g_5(0), \mu_7 = g_2(\lambda_2), \mu_8 = g_5(0), \mu_{12} = g_5(0) \]
\[ \mu_{13} = g_6(0), \mu_{16} = g_6(0) \]
\[ \mu_9 = g_5(0), \mu_{17} = (1 - g_5(\lambda_1)) \]
\[ \mu_{14} = \frac{1}{\lambda_1} (1 - g_5(\lambda_1)) \]
\[ m_{ij} \] is the unconditional mean time and mathematically is defined as:

\[ m_{ij} = \int_0^\infty t q_{ij}(t)dt = -q_{ij}^{\prime}(0) \]
\[ m_{01} = \mu_0 = \frac{1}{\lambda_1} \]
\[ m_{12} + m_{15}^4 = -g_1(0) = k_1(say), m_{12} + m_{14} = \mu_1 \]
\[ m_{23} + m_{28}^9 = -g_2(0) = k_2(say), m_{27} + m_{23} = \mu_2 \]
\[ m_{30} + m_{310}^{10} = -g_3(0) = k_3(say), m_{30} + m_{310} = \mu_3 \]
\[ m_{714} + m_{124}^{12} = -g_5(0) = k_4(say), m_{1417} + m_{15}^{15} = -g_5(0) = k_5(say) \]
\[ m_{170} + m_{171}^{18} = -g_6(0) = k_6(say), m_{67} = k_3, m_{56} = k_2, m_{97} = k_3, m_{1213} = k_5, m_{131} = k_6 \]
\[ m_{161} = k_6 \]
4. ANALYSIS OF MEAN TIME TO SYSTEM FAILURE

Applying the concept of regenerative processes and consider the failed states as absorbing states the following recursive relation for \( \phi_i(t) \) are obtained
\[
\phi_1(t) = q_01(t) \phi_1(t)
\]
\[
\phi_2(t) = q_12(t) \phi_1(t) + q_02(t) \phi_2(t)
\]
\[
\phi_3(t) = q_15(t) \phi_1(t) + q_30(t) \phi_3(t)
\]

these non homogenous system of equation can be solved by using Laplace- Stieltjes Transforms (L.S.T) and matrix method for \( \phi_1^*(s) \) is
\[
\frac{N(s)}{D(s)} = \frac{N(S)}{D(S)}
\]

Where,
\[
D(s) = 1 - q_01(s) Q_{121}(s) Q_{262}(s) Q_{1210}(s) + Q_{121}(s) Q_{262}(s) Q_{1210}(s)
\]
\[
N(s) = \lim_{s \to 0} \frac{1 - \phi_1^*(s)}{s} = \lim_{s \to 0} \frac{N(S)}{sD(s)} = \frac{N(0)}{D(0)}
\]

Where \( N = \mu_0 + \mu_1 + p_{12} \mu_2 + p_{12} p_{23} \mu_3 \)

And
\[
D = 1 - p_{12} p_{23} p_{30}
\]

5. AVALIABILITY ANALYSIS

\( A_1(t) \) denotes availability and by using the probability theory the following relations are obtained.
\[
A_0(t) = M_0(t) + q_01(t) A_1(t)
\]
\[
A_1(t) = M_1(t) + q_{12}(t) A_2(t) + q_{121}(t) A_3(t)
\]
\[
A_2(t) = M_2(t) + q_{23}(t) A_3(t) + q_{26}(t) A_4(t)
\]
\[
A_3(t) = M_3(t) + q_{30}(t) A_0(t) + q_{37}(t) A_1(t)
\]
\[
A_4(t) = q_{56}(t) A_1(t)
\]
\[
A_5(t) = M_5(t) + q_{141}(t) A_1(t) + q_{1417}(t) A_7(t)
\]
\[
A_6(t) = q_{70}(t) A_0(t), A_7(t)
\]
\[
A_{12}(t) = q_{1213}(t) A_{13}(t)
\]
\[
A_{13}(t) = q_{131}(t) A_0(t)
\]
\[
A_{14}(t) = M_{14}(t) + q_{1417}(t) A_{17}(t) + q_{1416}(t) A_{16}(t)
\]
\[
A_{16}(t) = q_{161}(t) A_0(t)
\]
\[
A_{17}(t) = M_{17}(t) + q_{170}(t) A_0(t) + q_{171}(t) A_1(t)
\]

Where
\[
M_0(t) = e^{-\lambda t} dt , M_1(t) = e^{-\lambda t} G_1(t) dt , M_2(t) = e^{-\lambda t} G_2(t) dt
\]
\[
M_3(t) = e^{-\lambda t} G_3(t) dt , M_4(t) = e^{-\lambda t} G_4(t) dt
\]
\[
M_{14}(t) = e^{-\lambda t} G_{24}(t) dt , M_{17}(t) = e^{-\lambda t} G_{46}(t) dt
\]

These non homogenous system of equation can be solved by using Laplace Transforms (L.T.) and matrix method for \( A_0^*(s) \), we obtain
\[
A_0^*(s) = \frac{N_2(s)}{D_1(s)}
\]

Where,
\[
N_2(s) = q_{101}(s) W_1^*(s)
\]

6. BUSY PERIOD ANALYSIS OF RESCUE TEAM DURING DIGGING OUT

\( B_0^R(t) = \) Probability that rescue team is busy during digging out at instant \( t \), when system entered regenerative state \( I \) at \( t=0 \).
\[
B_0^R(t) = q_{01}(t) \cap B_0^R (t)
\]
\[
B_0^R(t) = q_{12}(t) \cap B_0^R (t) \cap q_{121}(t) \cap B_0^R (t)
\]
\[
B_0^R(t) = q_{131}(t) \cap B_0^R (t)
\]
\[
B_0^R(t) = q_{1417}(t) \cap B_0^R (t) \cap q_{1416}(t) \cap B_0^R (t)
\]
\[
B_0^R(t) = q_{161}(t) \cap B_0^R (t)
\]
\[
B_0^R(t) = q_{170}(t) \cap B_0^R (t) \cap q_{171}(t) \cap B_0^R (t)
\]

Where
\[
W(t) = e^{-\lambda t} G_1(t) dt + \lambda e^{-\lambda t} G_1(t)
\]
\[
W_1(t) = e^{-\lambda t} G_1(t) dt + \lambda e^{-\lambda t} G_1(t)
\]

these non homogenous system of equation can be solved by using Laplace Transforms (L.T.) and matrix method for
\[
B_0^R(s), we obtain
\]
\[
B_0^R(s) = \frac{N_2(s)}{D_1(s)}
\]

Where
\[
N_2(s) = q_{101}(s) W_1^*(s)
\]
And $D_1(s)$ is already mentioned.

$$B_0 = \lim_{s \to 0}(sB_0^R(s)) = \lim_{s \to 0} \left( \frac{N_2(s)}{D_1(s)} \right) \frac{N_2(0)}{D_1(0)} - \frac{N_2}{D_1}$$

Where,

$$N_2 = W_t$$

Where $W_t = W_t'(0)$ and $D_1$ is already specified.

7. BUSY PERIOD ANALYSIS OF RESCUE TEAM DURING SNOW REMOVING IN RESCUE OPERATION

$B_{i}^{sc}(t)$ is Probability that the rescue team is busy under snow cutting/removing operation at instant t, given that the system entered regenerative state i at $t=0$.

$B_{0}^{sc}(t) = q_{01}(t) \oplus B_{1}^{sc}(t)$

$B_{1}^{sc}(t) = q_{21}(t) \oplus B_{2}^{sc}(t) + q_{12}^{(4)}(t) \oplus B_{2}^{sc}(t)$

$q_{12}^{(4)}(t) = W_2(t) + q_{32}(t) \oplus B_{2}^{sc}(t) + q_{12}^{(11)}(t) \oplus B_{2}^{sc}(t)$

$q_{12}^{(11)}(t) = q_{32}(t) \oplus B_{2}^{sc}(t)$

$q_{13}^{(15)}(t) = W_1(t) + q_{16}^{(15)}(t) \oplus B_{1}^{sc}(t)$

$q_{16}^{(15)}(t) = B_{1}^{sc}(t)$

$q_{17}^{(18)}(t) = q_{12}^{(18)}(t) \oplus B_{1}^{sc}(t)$

Where $W_2(t) = e^{-\lambda_2 t}G_2(t)dt + \lambda_2 e^{-\lambda_2 t}G_2(t)dt$ and $W_1(t) = G_1(t)dt$.

these non homogenous system of equation can be solved by using Laplace Transforms (L.T.) and matrix method for $B_{0}^{sc}(s)$, we obtain

$$B_{0}^{sc}(s) = \frac{N_2(s)}{D_1(s)}$$

Where

$$N_2(s) = q_{01}(s)q_{15}(s)W_2(s) + q_{03}(s)q_{12}(s)W_2(s)$$

And $D_1(s)$ is already mentioned.

$$B_{0}^{sc}(s) = \lim_{s \to 0}(sB_{0}^{sc}(s)) = \lim_{s \to 0} \left( \frac{N_2(s)}{D_1(s)} \right) \frac{N_2(0)}{D_1(0)} - \frac{N_2}{D_1}$$

Where,

$N_3 = W_3P_{15}^{(4)} + p_{12}W_2$

Where $W_2 = W_2'(0)$, $W_3 = W_3'(0)$ and $D_1$ is already mentioned.

8. BUSY PERIOD ANALYSIS OF RESCUE TEAM DURING HOSPITALIZATION IN RESCUE OPERATION

$B_{i}^{th}(t)$ = Probability that rescue team is busy during hospitalization given that the system entered regenerative state i at $t=0$.

$B_{0}^{th}(t) = q_{01}(t) \oplus B_{1}^{th}(t)$

$B_{1}^{th}(t) = q_{12}(t) \oplus B_{2}^{th}(t) + q_{15}^{(4)}(t) \oplus B_{2}^{th}(t)$

$q_{15}^{(4)}(t) = W_2(t) + q_{32}(t) \oplus B_{2}^{th}(t) + q_{12}(t) \oplus B_{2}^{th}(t)$

$q_{13}(t) = q_{32}(t) \oplus B_{2}^{th}(t)$

$q_{17}(t) = q_{12}^{(18)}(t) \oplus B_{1}^{th}(t)$

$q_{18}(t) = q_{12}^{(18)}(t) \oplus B_{1}^{th}(t)$

Where $W_3(t) = e^{-\lambda_2 t}G_3(t)dt + \lambda_2 e^{-\lambda_2 t}G_3(t)dt$ and $W_5(t) = G_5(t)dt$.

these non homogenous system of equation can be solved by using Laplace Transforms (L.T.) and matrix method for $B_{0}^{th}(s)$, we obtain

$$B_{0}^{th}(s) = \frac{N_4(s)}{D_1(s)}$$

Where

$$N_4(s) = q_{01}(s)q_{12}(s)q_{23}(s)W_3'(s) + q_{03}(s)q_{15}^{(4)}(s)q_{56}(s) + q_{51}(s)q_{12}(s)q_{26}^{(7)}(s)W_6(s)$$

And $D_1(s)$ is already mentioned.

$$B_{0}^{th}(s) = \lim_{s \to 0}(sB_{0}^{th}(s)) = \lim_{s \to 0} \left( \frac{N_4(s)}{D_1(s)} \right) \frac{N_4(0)}{D_1(0)} - \frac{N_4}{D_1}$$

Where,

$N_4 = p_{12}p_{23}W_3 + p_{12}^{(4)}p_{56}W_6 + p_{12}p_{26}^{(7)}W_6$

Where $W_3 = W_3'(0)$, $W_5 = W_5'(0)$ and $D_1$ is already mentioned.
9. MEAN NUMBER OF VISITS BY THE REPAIR MAN

We define

\[ V_0(t) = \text{Mean number of visits by the rescue team in (0,t], given that the system started from the regenerative state i at t=0} \]

\[
\begin{align*}
V_0(t) &= q_{01}(t) \ast (1+V_1(t)) \\
V_1(t) &= q_{12}(t) \ast V_2(t) + q_{15}^{(4)}(t) \ast V_0(t) \\
V_2(t) &= q_{23}(t) \ast V_3(t) + q_{26}^{(7)}(t) \ast V_0(t) \\
V_3(t) &= q_{30}(t) \ast V_0(t) + q_{31}(t) \ast V_1(t) \\
V_5(t) &= q_{56}(t) \ast V_6(t) \\
V_6(t) &= q_{61}(t) \ast V_1(t) \\
V_7(t) &= q_{714}(t) \ast V_{14}(t) + q_{712}^{(11)}(t) \ast V_{12}(t) \\
V_0(t) &= q_{97}(t) \ast V_7(t) \\
V_{12}(t) &= q_{1213}(t) \ast V_{13}(t) \\
V_{13}(t) &= q_{131}(t) \ast V_1(t) \\
V_{14}(t) &= q_{1417}(t) \ast V_{17}(t) + q_{1416}^{(15)}(t) \ast V_{16}(t) \\
V_{16}(t) &= q_{161}(t) \ast V_1(t) \\
V_{17}(t) &= q_{170}(t) \ast V_0(t) + q_{171}^{(18)}(t) \ast V_1(t)
\end{align*}
\]

these non homogenous system of equation can be solved by using Laplace- Stieltjes Transforms (L.S.T) and matrix method for \( V_0^*(s) \), we obtain

\[
V_0^*(s) = \frac{N_5(s)}{D_1(s)}
\]

Where

\[
N_5(s) = Q_{01}^*(s) - Q_{01}^{(4)}(s) - Q_{12}^*(s) + Q_{12}^{(7)}(s) - Q_{23}^*(s) + Q_{23}^{(11)}(s) - Q_{31}^{(15)}(s) - Q_{56}^*(s) + Q_{56}^{(18)}(s) - Q_{61}^*(s) + Q_{61}^{(19)}(s) - Q_{714}^*(s) + Q_{714}^{(11)}(s) - Q_{712}^{(15)}(s) - Q_{97}^*(s) + Q_{97}^{(11)}(s) - Q_{1213}^*(s) + Q_{1213}^{(15)}(s) - Q_{131}^*(s) + Q_{131}^{(19)}(s) - Q_{1417}^*(s) + Q_{1417}^{(11)}(s) - Q_{1416}^{(15)}(s) - Q_{161}^*(s) + Q_{161}^{(19)}(s) - Q_{170}^*(s) + Q_{170}^{(18)}(s) - Q_{171}^*(s) + Q_{171}^{(19)}(s)
\]

And \( D_1(s) \) is already mentioned.

10. COST- BENEFIT ANALYSIS

The total expected benefit for the system in a stable state is given by

\[
P = C_0A_0 - C_{11}B_0^R - C_{11}B_0^{SC} - C_{12}B_0^R - C_{2}V_0
\]

Where

\( C_0 \) is revenue per unit time of the system , \( C_{11}, C_{12}, C_{13} \) are the cost per unit time for which rescue team is busy during digging out, snow cutting and hospitalization respectively and \( C_2 \) is cost per visit of rescue team.

11. NUMERICAL RESULTS

Numerical result for the particular cases the following case is considered.

\[
g_1(t) = \alpha_1 e^{-\alpha_1 t}, g_2(t) = \alpha_2 e^{-\alpha_2 t} \text{ and } g_3(t) = \alpha_3 e^{-\alpha_3 t}, g_4(t) = \alpha_4 e^{-\alpha_4 t}, g_5(t) = \alpha_5 e^{-\alpha_5 t} \text{ and } g_6(t) = \alpha_6 e^{-\alpha_6 t}
\]

12. GRAPHICAL INTERPRETATION

Figure 2 shows that with increase the failure rate the availability of the system is decreases. Availability has more value to get more value from the repair rate. The aspect of profitability has been studied graphically in relation to
different parameters and using the expressions for various measures of system effectiveness, as shown in Figures 3 to 4.

<table>
<thead>
<tr>
<th>Fig.No</th>
<th>Graphs</th>
<th>Other fixed Parameters</th>
<th>Profit For Profit70</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Profit Versus $C_0$</td>
<td>$\alpha_1=7, \alpha_2=9, \alpha_1=1.5, \alpha_2=2, \alpha_3=3.5, \alpha_4=3.6, C_0=600, C_1=800, C_2=900$</td>
<td>$\delta=0.8, 0.9, \gamma_1=1.5, \gamma_2=2, \gamma_3=3, \gamma_4=3.4, \gamma_5=3.5, \gamma_6=3.6, C_1=600, C_2=800, C_3=900$</td>
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<td></td>
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<td>Increase $C_0$</td>
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<td>$C_2=500$</td>
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<td>$C_2=700$ C, $C_2=831.85$</td>
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<td>$C_2=900$ C, $C_2=916.17$</td>
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<td>4</td>
<td>Profit Versus $C_{12}$</td>
<td>$\alpha_1=7, \alpha_2=9, \alpha_1=1.5, \alpha_2=2, \alpha_3=3.5, \alpha_4=3.6, C_0=600, C_1=900, C_2=800$</td>
<td>$\delta=0.8, 0.9, \gamma_1=1.5, \gamma_2=2, \gamma_3=3.5, \gamma_4=3.6, \gamma_5=3.5, \gamma_6=3.6, C_1=600, C_2=800, C_3=900$</td>
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<td>Increase $C_2$</td>
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<td>With increases $C_{12}$</td>
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<td>$C_2=100$</td>
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<td>$C_2=120$</td>
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<td>$C_{12}=356.62$</td>
</tr>
<tr>
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<td>$C_{12}=640.85$</td>
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<tr>
<td></td>
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<td>$C_{12}=925.14$</td>
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REFERENCES


