International Journal of Applied Research 2016; 2(8): 794-801

International Journal of Applied Research

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2016; 2(8): 794-801
www.allresearchjournal.com
Received: 24-06-2016
Accepted: 25-07-2016

Ritu Bansal
Research Scholar, J.J.T. University, Jhunjhunu, Rajasthan, India

Dr. Pardeep Goel
Associate Professor M.M. (P.G.) College, Fatehabad-Haryana, India

Correspondence
Ritu Bansal
Research Scholar, J.J.T. University, Jhunjhunu, Rajasthan, India

Availability analysis of two hosts systems

Ritu Bansal and Dr. Pardeep Goel

Abstract
This paper analysis two host system prevalent in banking industries using RPGT for system parameters considering constant mean time to failure and repair for hardware and software followed by illustration and special cases.

Keywords: Availability, base-state, regenerative point graphical technique (RPGT), system parameters

Introduction

This paper analyses two host system prevalent in banking industry is using RPGT for system parameters MTSF, Availability, Busy Period of the Server Visits, Expected Number of Server Visits considering constant mean time to failure and repair for hardware and software. Considering the importance of individual units in system Kumar, J. & Malik, S. C. [1] have discussed the concept of preventive maintenance for a single unit system. Liu. R. [2], Malik, S.C. [3], Nakagawa, T. and Osaki, S. [4] have discussed reliability analysis of a one unit system with un-repairable spare units and its applications. Goel, P. & Singh J. [5], Gupta, P., Singh, J. & Singh, I.P. [6], Kumar, S. & Goel, P. [7], Gupta, V. K. [8], Chaudhary, Goel & Kumar [9] Sharma & Goel [10], Ritikesh & Goel [11] and Goyal & Goel [12] have discussed behavior of systems with perfect and imperfect switch-over of systems using various techniques.

Model Description: Two hosts system is the availability analysis of a banking industry having two hosts is considered. In a bank branch where there are to hosts, each host have a software (S) operated by a hardware (S). Here, in the present study there are two hosts with software S_1, S_2 operated by hardware H_1, H_2 respectively. Both hardware are of equal capacity with failure rate λ_1 mean repair rate w_1 thus $2\lambda_1$, is their combined mean failure rate. Software is similar function which may become inoperable obsolete or need updating by some time with mean failure rate λ_2, so combined failure rate if software is $2\lambda_2$ and repair / updating rates w_2 each. Separate repairman/ servers are available for hardware and software. If any one of the two hardware fail then it will not be able to run the software hence the system works in reduced capacity or vice-versa i.e. when the software is outdated/ failed then it will not serve any purpose to run it any the hardware, thus the system will also work in reduced state. If both the hardware fails, then the whole of the system is in failed state S_2, similarly if the software are in failed state then hole of the system is in failed state S_5 if anyone hardware out of any two hardware fails. Then the system works in reduced capacity denoted by state S_1, similarly if one of the two softwares fails and hardware are good. Then again the system works in reduced state denoted by S_4, if both the software fail then the system real has the failed state denoted S_5 of either of the hardware and its complementary software fail, then again the system reaches failed state denoted by S_3, where two separate repairman for hardware and software are available, if the hardware is repaired first then system is transited to state S_1 and if software is repaired first then the system transited to state S_4.

Assumptions and Notations: The following assumptions and notations are taken: -

1. Separate repair facilities are available for hardware and software.
2. The distributions of failure times and repair times are exponential and general respectively and also different.
3. Failures and repairs are statistically independent.
4. Repair is perfect and repaired system is as good as new one.
5. Nothing can fail when the system is in failed state.
6. The system is discussed for steady-state conditions.
7. Repair facility is immediate.

$\overline{cycle}$: A circuit formed through un-failed states. m-cycle: A circuit (may be formed through regenerative or non-regenerative / failed state) whose terminals are at the regenerative state m.

$m-\overline{cycle}$: A circuit (may be formed through un-failed regenerative or non-regenerative state) whose terminals are at the regenerative m state.

$\left(i \xrightarrow{Sr} j\right)$: r-th directed simple path from i-state to j-state; r takes positive integral values for different paths from i-state to j-state.

$\left(\xi \xrightarrow{sff} i\right)$: A directed simple failure free path from ξ -state to i-state.

$V_{m,m}$: Probability factor of the state m reachable from the terminal state m of the m-cycle.

$V_{\overline{m,m}}$: Probability factor of the state m reachable from the terminal state m of the $m-\overline{cycle}$.

R_i (t) : Reliability of the system at time t, given that the system entered the un-failed regenerative state 'i' at t = 0.

A_i (t) : Probability of the system in up time at time 't', given that the system entered regenerative state 'i' at t = 0.

B_i (t) : Reliability that the server is busy for doing a particulars job at time 't'; given that the system entered regenerative state 'i' at t = 0.

V_i (t) : The expected no. of server visits for doing a job in (o,t] given that the system entered regenerative state 'i' at t = 0.

',' : denote derivative

W_i (t) : Probability that the server is busy doing a particular job at time t without transiting to any other regenerative state 'i' through one or more non-regenerative states, given that the system entered the regenerative state 'i' at t = 0.

μ_i : Mean sojourn time spent in state i, before visiting any other states;

$\mu_i = \int_0^\infty R_i(t)dt$

μ_i^1 : The total un-conditional time spent before transiting to any other regenerative states, given that the system entered regenerative state 'i' at t=0.

n_i : Expected waiting time spent while doing a given job, given that the system entered regenerative state 'i' at t=0; $\eta_i = W_i^*(0)$.

ξ : Base state of the system.

f_j : Fuzziness measure of the j-state.

λ_1, λ_2 : Constant failure rate of hosts etc.

H_i/h_i : Unit in full capacity working / failed state of hosts, similarly for servers S_1 & S_2.

w_i : are constant repair rates of units.

○ Regenerative State, ⬭ Reduced State, □ Failed State.

Following the above assumptions and notations the Transition Diagram of the system is given in Figure 1.

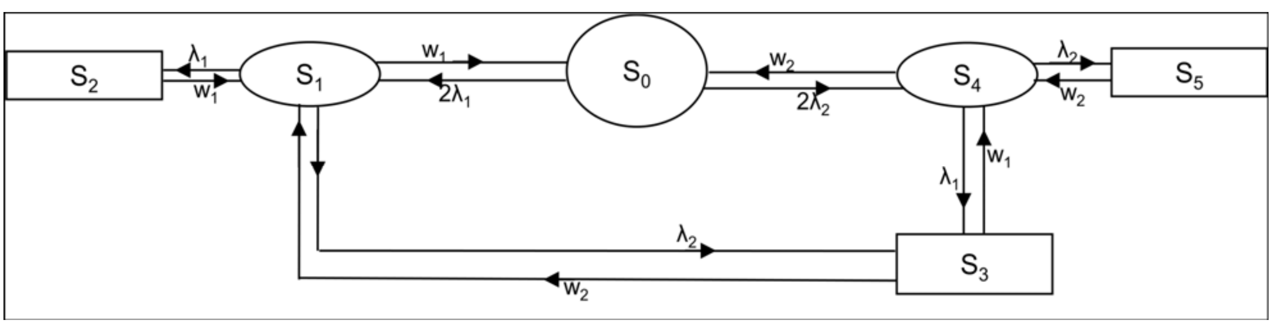

Fig 1

$S_0 = H_1H_2S_1S_2$, $S_1 = H_ih_jS_1S_2$, $i \neq j$, i, j = 1, 2, $S_2 = h_1h_2S_1S_2$

$S_3 = h_iH_js_jS_i$, $i \neq j$, i, j = 1, 2, $S_4 = H_1H_2S_is_j$, $i \neq j$, i, j = 1, 2, $S_5 = H_1H_2s_1s_2$

Table 1: Simple Paths from vertices

Vertex i	0	1	2	3	4	5
0	(0,1,0) (0,4,0) (0,1,3,4,0)	(0,1) (0,4,3,1)	(0,1,2) (0,4,3,1,2)	(0,1,3) (0,4,3)	(0,4) (0,1,3,4)	(0,4,5) (0,1,3,4,5)
1	(1,0) (1,3,4,0)	(1,2,1) (1,3,4,0,1) (1,0,1) (1,3,1)	(1,2)	(1,3) (1,0,4,3)	(1,0,4) (1,3,4)	(1,0,4,5) (1,3,4,5)
2	(2,1,0) (2,1,3,4,0)	(2,1)	(2,1,2)	(2,1,3) (2,1,0,4,3)	(2,1,0,4) (2,1,3,4)	(2,1,0,4,5) (2,1,3,4,5)
3	(3,1,0) (3,4,0)	(3,1) (3,4,0,1)	(3,1,2) (3,4,0,1,2)	(3,1,3) (3,4,3) (3,1,0,4,3)	(3,4) (3,1,0,4)	(3,0,4,5) (3,4,5)
4	(4,0) (4,3,1,0)	(4,0,1) (4,3,1)	(4,0,1,2) (4,3,1,2)	(4,3) (4,0,1,3)	(4,3,4) (4,5,4) (4,0,4) (4,0,1,3,4)	(4,5)
5	(5,4,0) (5,4,3,1,0)	(5,4,0,1) (5,4,3,1)	(5,4,0,1,2) (5,4,3,1,2)	(5,4,3) (5,4,0,1,3)	(5,4)	(5,4,5)

The possible transitions rates between states along with transition states are shown in Figure 1. Primary, Secondary and Tertiary Circuits associated with the system are given in Table 2.

Table 2: Primary, Secondary & Tertiary Circuits at various vertices.

Vertex i	Primary Circuits (CL 1)	Secondary Circuits (CL 2)	Tertiary Circuits (CL 3)	Tetra Circuits (CL 4)
0	(0,1,0) (0,4,0) (0,1,3,4,0)	(1,2,1) (1,3,1) (4,5,4) (4,3,4) (1,2,1) (1,3,1) (3,4,3) (4,5,4)	Nil (3,4,3) Nil (3,1,3) Nil (3,4,3) (4,5,4) Nil	Nil (4,5,4) Nil (1,2.1) Nil (4,5,4) Nil Nil
1	(1,2,1) (1,3,4,0,1) (1,0,1) (1,3,1)	Nil (3,4,3) (4,5,4) (0,4,0) (0,4,0) (3,4,3)	Nil (4,5,4) (4,0,4) Nil (4,5,4) (4,3,4) (4,5,4) (4,3,4) (4,5,4) (4,0,4)	Nil Nil Nil Nil Nil Nil Nil Nil Nil Nil
2	(2,1,2)	(1,0,1) (1,3,1) (1,0,4,3,1)	(0,4,0) (3,4,3) (0,4,0) (4,3,4) (4,5,4)	(4,5,4) (4,3,4) (4,5,4) (4,0,4) (4,5,4) (4,3,4) Nil Nil
3	(3,1,3) (3,4,3) (3,1,0,4,3)	(1,0,1) (1,2,1) (4,0,4) (4,5,4) (1,0,1) (1,2,1) (0,4,0) (4,5,4)	(0,4,0) Nil (0,1,0) Nil (0,4,0) Nil (4,5,4) Nil	(4,5,4) Nil (1,2,1) Nil (4,5,4) Nil Nil Nil
4	(4,3,4) (4,5,4) (4,0,4)	(3,1,3) Nil (0,1,0)	(1,0,1) (1,2,1) Nil (1,3,1) (1,2,1)	Nil Nil Nil Nil Nil

	(4,0,1,3,4)	(0,1,0) (1,2,1) (3,1,3)	(1,3,1) (1,2,1) Nil (1,0,1) (1,2,1)	Nil Nil Nil Nil Nil
5	(5,4,5)	(4,3,4) (4,0,4) (4,0,1,3,4)	(3,1,3) (0,1,0) (0,1,0) (1,2,1) (1,3,1)	(1,0,1) (1,2,1) (1,2,1) (1,3,1) (1,3,1) (1,2,1) Nil Nil

From the table 2, we see that at working state ‘1’ there are maximum number of primary circuits, hence state ‘1’ is the base state.

Table 3: Primary, Secondary, Tertiary Circuits w.r.t. the Simple Paths (Base-State ‘1’)

Vertex j	$\left(1 \xrightarrow{S_r} j\right)$: (P0)	(P1)	(P2)
0	$\left(1 \xrightarrow{S_1} 0\right)$: (1,0) $\left(1 \xrightarrow{S_2} 0\right)$: (1,3,4,0)	(0,4,0) (3,4,3) (4,5,4) (0,4,0)	(4,5,4) (4,3,4) (4,5,4) (4,0,4) Nil (4,5,4) (4,3,4)
1	$\left(1 \xrightarrow{S_1} 1\right)$: (1,2,1) $\left(1 \xrightarrow{S_2} 1\right)$: (1,0,1) $\left(1 \xrightarrow{S_3} 1\right)$: (1,3,4,0,1) $\left(1 \xrightarrow{S_4} 1\right)$: (1,3,1)	Nil (0,4,0) (0,4,0) (3,4,3) (4,5,4) (4,0,4) (3,4,3)	(4,5,4) (4,3,4) (4,5,4) (4,3,4) (4,5,4) (4,0,4) Nil Nil (4,5,4) (4,0,4)
2	$\left(1 \xrightarrow{S_1} 2\right)$: (1,2)	Nil	Nil
3	$\left(1 \xrightarrow{S_1} 3\right)$: (1,3) $\left(1 \xrightarrow{S_2} 3\right)$: (1,0,4,3)	(3,4,3) (0,4,0) (4,5,4) (4,3,4)	(4,5,4) (4,0,4) (4,5,4) (4,3,4) Nil Nil
4	$\left(1 \xrightarrow{S_1} 4\right)$: (1,0,4) $\left(1 \xrightarrow{S_2} 4\right)$: (1,3,4)	(0,4,0) (4,5,4) (4,3,4) (3,4,3) (4,5,4) (4,0,4)	(4,5,4) Nil Nil (4,0,4) (4,5,4) Nil (4,5,4) (4,3,4)
5	$\left(1 \xrightarrow{S_2} 5\right)$: (1,0,4,5) $\left(1 \xrightarrow{S_2} 5\right)$: (1,3,4,5)	(0,4,0) (4,5,4) (4,3,4) (3,4,3) (4,5,4) (4,0,4)	(4,5,4) (4,3,4) Nil Nil (4,5,4) (4,0,4) Nil Nil

Path Probabilities and Mean Sojourn Times.

$q_{i,j}(t)$ **:** Probability density function (p.d.f.) of the first passage time from a regenerative state ‘i’ to a regenerative state ‘j’ or to a failed state ‘j’ without visiting any other regenerative state in (0,t].

$p_{i,j}$ **:** Steady state transition probability from a regenerative state ‘i’ to a regenerative state ‘j’ without visiting any other regenerative state. $p_{i,j} = q_{i,j}^*(0)$; where * denotes Laplace transformation.

Table 4: Path Probabilities

$q_{i,j}(t)$	$p_{ij} = q^*_{i,j}(t)$
$q_{0,1}(t) = 2\lambda_1 e^{-(2\lambda_1+2\lambda_2)t}$ $q_{0,4}(t) = 2\lambda_2 e^{-(2\lambda_1+2\lambda_2)t}$	$p_{0,1} = \lambda_1/(\lambda_1+\lambda_2)$ $p_{0,4} = \lambda_2/(\lambda_1+\lambda_2)$
$q_{1,0}(t) = w_1 e^{-(w_1+\lambda_2+\lambda_1)t}$ $q_{1,2}(t) = \lambda_1 e^{-(w_1+\lambda_2+\lambda_1)t}$ $q_{1,3}(t) = \lambda_2 e^{-(w_1+\lambda_2+\lambda_1)t}$	$p_{1,0} = w_1/(w_1+\lambda_1+\lambda_2)$ $p_{1,2} = \lambda_1/(w_1+\lambda_1+\lambda_2)$ $p_{1,3} = \lambda_2/(w_1+\lambda_1+\lambda_2)$
$q_{2,1} = w_1 e^{-w_1 t}$	$p_{2,1} = 1$
$q_{3,1}(t) = w_2 e^{-(w_1+w_2)t}$ $q_{3,4}(t) = w_1 e^{-(w_1+w_2)t}$	$p_{3,1} = w_2/(w_1+w_2)$ $p_{3,4} = w_1/(w_1+w_2)$
$q_{4,0}(t) = w_2 e^{-(\lambda_1+\lambda_2+w_2)t}$ $q_{4,3}(t) = \lambda_1 e^{-(\lambda_1+\lambda_2+w_2)t}$ $q_{4,5}(t) = \lambda_2 e^{-(\lambda_1+\lambda_2+w_2)t}$	$p_{4,0} = w_2/(\lambda_1+\lambda_2+w_2)$ $p_{4,3} = \lambda_1/(\lambda_1+\lambda_2+w_2)$ $p_{4,5} = \lambda_2/(\lambda_1+\lambda_2+w_2)$
$q_{5,4}(t) = w_2 e^{-w_2 t}$	$p_{5,4} = 1$

It is verified that $p_{0,1}+p_{0,4} = 1$, $p_{1,0}+p_{1,2}+p_{1,3} = 1$, $p_{2,1} = 1$, $p_{3,1}+p_{3,4} = 1$,
$P_{4,3}+p_{4,0}+p_{4,5} = 1$, $p_{5,4} = 1$

Table 5: Mean Sojourn Times

$R_i(t)$	$\mu_i=R_i^*(0)$
$R_0(t) = e^{-2(\lambda_2+\lambda_1)t}$	$\mu_0 = 1/2(\lambda_2+\lambda_1)$
$R_1(t) = e^{-(\lambda_1+\lambda_2+w_1)t}$	$\mu_1 = 1/(\lambda_1+\lambda_2+w_1)$
$R_2(t) = e^{-w_1 t}$	$\mu_2 = 1/(w_1)$
$R_3(t) = e^{-(w_1+w_2)t}$	$\mu_3 = 1/(w_1+w_2)$
$R_4(t) = e^{-(\lambda_1+\lambda_2+w_2)t}$	$\mu_4 = 1/(\lambda_1+\lambda_2+w_2)$
$R_5(t) = e^{-w_2 t}$	$\mu_5 = 1/w_2$

MTSF (T_0): The regenerative un-failed states to which the system can transit (initial state '0'), before entering any failed state are: 'i' = 0,1,4 taking 'ξ' = '1'.

$$\text{MTSF } (T_0) = \left[\sum_{i,sr}\left\{\frac{\left\{pr\left(\xi \xrightarrow{sr(sff)} i\right)\right\}\mu i}{\Pi_{m_1\neq\xi}\{1\text{-}V_{\overline{m_1 m_1}}\}}\right\}\right] \div \left[1\text{-}\sum_{sr}\left\{\frac{\left\{pr\left(\xi \xrightarrow{sr(sff)} \xi\right)\right\}}{\Pi_{m_2\neq\xi}\{1\text{-}V_{\overline{m_2 m_2}}\}}\right\}\right]$$

$= (V_{0,0}\mu_0+V_{0,1}\mu_1+V_{0,4}\mu_4)/(V_{0,0}\mu_0+V_{0,1}\mu_1+V_{0,2}\mu_2+V_{0,3}\mu_3+V_{0,4}\mu_4+V_{0,5}\mu_5)$

Availability of the System: The regenerative states at which the system is available are 'j' = 0,1, 2 and taking 'ξ' = '1' the total fraction of time for which the system is available is given by

$$A_0 = \left[\sum_{j,sr}\left\{\frac{\{pr(\xi^{sr\to}j)\}fj,\mu j}{\Pi_{m_1\neq\xi}\{1\text{-}V_{\overline{m_1 m_1}}\}}\right\}\right] \div \left[\sum_{i,s_r}\left\{\frac{\{pr(\xi^{sr\to}i)\}\mu_i^1}{\Pi_{m_2\neq\xi}\{1\text{-}V_{\overline{m_2 m_2}}\}}\right\}\right]$$

$= \left[\sum_j V_{\xi,j}, f_j, \mu_j\right] \div \left[\sum_i V_{\xi,i}, f_j, \mu_i^1\right]$

$= (V_{1,1}\mu_1+V_{1,0}\mu_0+V_{1,4}\mu_4)/(V_{1,0}\mu_0+V_{1,1}\mu_1+V_{1,2}\mu_2+V_{1,3}\mu_3+V_{1,4}\mu_4+V_{1,5}\mu_5)$

Busy Period of the Server: The regenerative states where servers 'j' = 1,2,3,4,5 and regenerative states are 'i' = 0 to 5, taking ξ = '1', the total fraction of time for which the servers remains busy is given by

$$B_0 = \left[\sum_{j,sr}\left\{\frac{\{pr(\xi^{sr\to}j)\},nj}{\Pi_{m_1\neq\xi}\{1\text{-}V_{\overline{m_1 m_1}}\}}\right\}\right] \div \left[\sum_{i,s_r}\left\{\frac{\{pr(\xi^{sr\to}i)\}\mu_i^1}{\Pi_{m_2\neq\xi}\{1\text{-}V_{\overline{m_2 m_2}}\}}\right\}\right]$$

$= \left[\sum_j V_{\xi,j}, n_j\right] \div \left[\sum_i V_{\xi,i}, \mu_i^1\right]$

$= (V_{1,1}\mu_1+V_{1,2}\mu_2+V_{1,3}\mu_3+V_{1,4}\mu_4+V_{1,5}\mu_5)/D_1$

Expected Number of Inspections by the repair man: The regenerative states where the repair men join for repair a fresh are 1, 2 to do this job j = 1 the regenerative states are i = 0 to 5, Taking 'ξ' = '1', the fractional number of visits by the repairmen is given by

$$V_0 = \left[\sum_{j,sr}\left\{\frac{\{pr(\xi^{sr\to}j)\}}{\Pi_{k_1\neq\xi}\{1\text{-}V_{\overline{K_1 K_1}}\}}\right\}\right] \div \left[\sum_{i,s_r}\left\{\frac{\{pr(\xi^{sr\to}i)\}\mu_i^1}{\Pi_{k_2\neq\xi}\{1\text{-}V_{\overline{K_2 K_2}}\}}\right\}\right]$$

$= \left[\sum_j V_{\xi,j}\right] \div \left[\sum_i V_{\xi,i}, \mu_i^1\right]$

$= (V_{1,1}+V_{1,4})/D_1$

Particular Cases

MTSF (T_0) = $(1/D)[(1/4\lambda)+\{(2w+3\lambda)/4(w+\lambda)(w+2\lambda)\}][\{2w/(w+\lambda)\}+\{\lambda(w+4\lambda)/(w+4\lambda)$
$(w+\lambda)-\lambda\}+\{\lambda w(2w+3\lambda)/(2w+\lambda)^2(w+\lambda)\}]$

Where $D = V_{0,0}\mu_0+ V_{0,1}\mu_1+V_{0,2}\mu_2+ V_{0,3}\mu_3+V_{0,4}\mu_4+V_{0,5}\mu_5$

Table 6: MTSF Table

T_0	w = 0.60	w = 0.80	w = 1
λ = 0.1	0.84	0.94	0.98
λ = 0.2	0.77	0.79	0.94

MTSF Graph

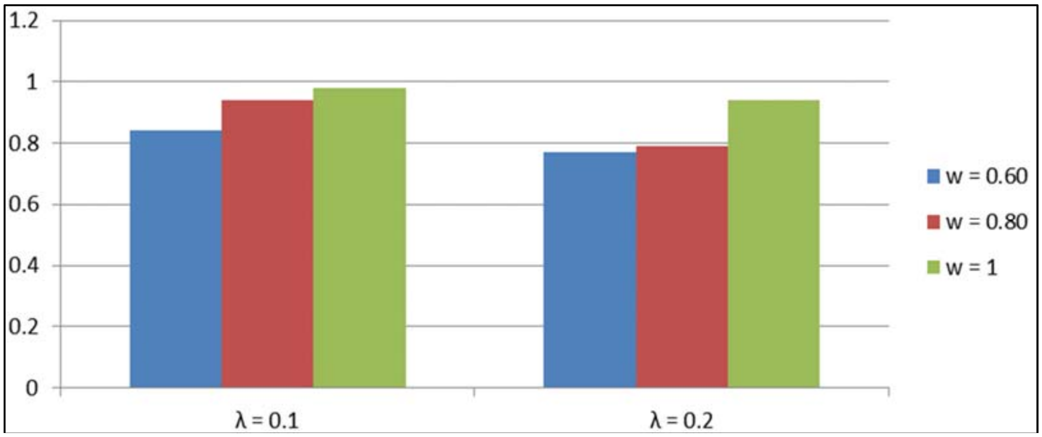

Fig 2

Availability of the System (A_0) = $[(1/D_1)(V_{1,1}\mu_1+V_{1,0}\mu_0+V_{1,4}\mu_4)]$
Where $D_1 = (V_{1,0}\mu_0+V_{1,1}\mu_1+V_{1,2}\mu_2+V_{1,3}\mu_3+V_{1,4}\mu_4+V_{1,5}\mu_5)$
$= (1/D_1)[\{1/(w+2\lambda)\}+\{1(w+\lambda)(2w+3\lambda)/4\lambda(w+\lambda)+(2w+3\lambda)-w(w+2\lambda)\}]$
$[\{w/(w+2\lambda)\}+\{\lambda w(w+4\lambda)/2(w+2\lambda)(w+2\lambda)(w+4\lambda)-\lambda(w+4\lambda)-\lambda(w)\}$
$+\{4w/(2w+3\lambda)(w+2\lambda)\}+\{\lambda/2(w+2\lambda)\}][(w+4\lambda)/(w+\lambda)(w+4\lambda)-\lambda(w+2\lambda)]$
$\{1/(w+\lambda)\}$
$= (1/D_1)[\{1/(w+2\lambda)\}+\{1+(w+\lambda)(2w+3\lambda)/4\lambda(w+\lambda)+(2w+3\lambda)-w(w+2\lambda)\}]$
$[w+\{\lambda w(w+4\lambda)/2(w+2\lambda)(w+4\lambda)-2\lambda(w+3\lambda)\} +\{4w/(2w+3\lambda)\}+\{\lambda(w+4\lambda)$
$(w+\lambda)\ (2w+3\lambda)-w(w+2\lambda)/2(w+\lambda)(w+4\lambda)-\lambda(w+2\lambda)(w+\lambda)\}]$
$= [1/(w+2\lambda)1+\{1+(w+\lambda)(2w+3\lambda)/4\lambda(w+\lambda)+(2w+3\lambda)-w(w+2\lambda)\}]$
$[w+\{\lambda w(w+4\lambda)/2(w+2\lambda)(w+4\lambda)-2\lambda(w+3\lambda)\}+\{4w/(2w+3\lambda)\}+\{\lambda(w+4\lambda)$
$(w+\lambda)(2w+3\lambda)-w(w+2\lambda)/2(w+\lambda)(w+4\lambda)-\lambda(w+2\lambda)(w+\lambda)(2w+3\lambda)\}+\lambda$
$+\{\lambda(w+\lambda)(w+4\lambda)/(w+\lambda)(w+4\lambda)-\lambda(w+2\lambda)\}+\{w\lambda(w+\lambda)/4(w+2\lambda)^3\}$
$-\{w^2\lambda/4(w+2\lambda)^2\}+\{\lambda w/(w+\lambda)(2w+3\lambda)-w(w+2\lambda)\}+\{\lambda^2/(w+\lambda)(w+4\lambda)-\lambda\ (w+2\lambda)\}]$

Table 7: Availability Table

A_0	w = 0.60	w = 0.80	w = 1
λ = 0.1	0.948	0.955	0.989
λ = 0.2	0.861	0.878	0.863
λ = 0.3	0.830	0.984	0.989

Availability of the System Graph

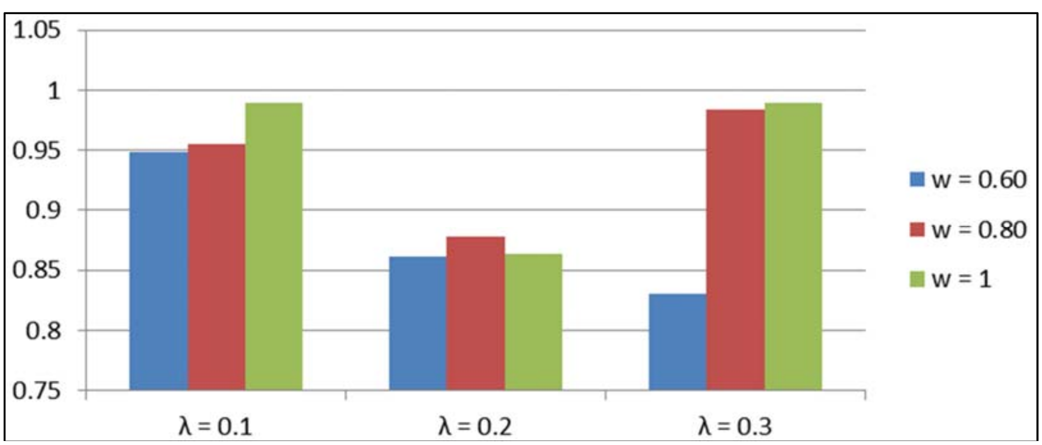

Fig 3

Busy Period of the Server (B_0) = $[1-(V_{1,0}\mu_0/D_1)]$, $= [1-(\mu_0/D_1)]$, $= [1-(1/4\lambda D_1)]$

Table 8: Busy Period of the Server Table

B_0	w = 0.60	w = 0.80	w = 1
λ = 0.1	0.663	0.643	0.628
λ = 0.2	0.7241	0.707	0.702
λ = 0.3	0.742	0.689	0.662

Busy Period of the Server Graph

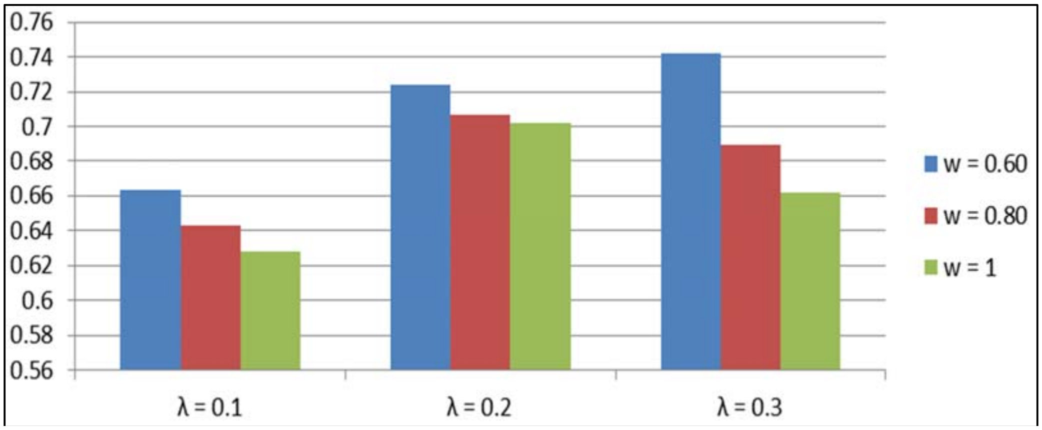

Fig 4

Expected Number of Server's Visits (V_0) = $(1/D_1)$ $[1+\{4w/(2w+3\lambda)(w+2\lambda)\}$
$+\{\lambda/2(w+2\lambda)\}\{(w+4\lambda)/(w+\lambda)(w+4\lambda)-\lambda$
$(w+2\lambda)\}\{1/(w+\lambda)(2w+3\lambda)\}]$

Table 9: Expected Number of Server's Visits Table

V_0	w = 0.60	w = 0.80	w = 1
λ = 0.1	0.417	0.388	0.366
λ = 0.2	0.536	0.528	0.504
λ = 0.3	0.631	0.730	0.763

Expected Number of Server Visits Graph

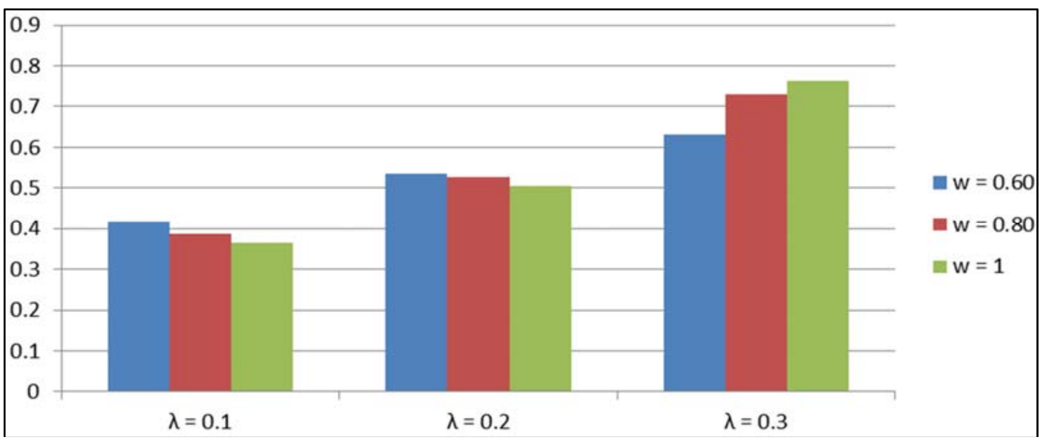

Fig 5

Profit Function
$= A_0R_0 - K_0B_1 - K_1$ (No. of Visits)
$= 500\,A_0 - 200\,B_0 - 100$ (No. of Visits)
Taking $R_0 = 500$ $K_0 = 200$ $K_1 = 100$

Table 10: Profit Function Table

	w = 0.60	w = 0.80	w = 1
λ = 0.1	299.70	310.10	332.30
λ = 0.2	232.08	244.80	240.70
λ = 0.3	203.50	281.20	310.80

Profit Function Graph

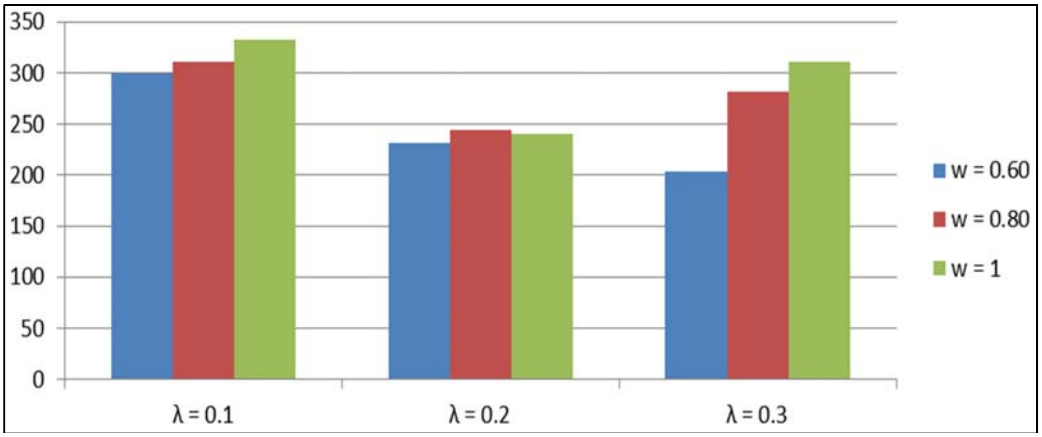

Fig 6

Conclusion: From above tables and graph we see that the result obtained using Regenerative Point Graphical Technique is practical, trendy and same as obtained by using Regenerative Point Technique and other techniques. But in Regenerative Point Graphical Technique, we obtained the results very easily and quickly without writing any state equations and without any cumbersome procedures, long calculations and simplifications. Regenerative Point Graphical Technique is applied to study the behavior and profit analysis of various process industries like soap, soft drink and dairy plant, paper industry, soap industry etc. It is hoped that the Regenerative Point Graphical Technique for the analysis of the system will be very helpful to the managements, manufactures and the personal engaged in reliability engineering and working for the behavior and profit analysis of stochastic systems.

References

1. Kumar J, Kadyan MS, Malik SC, Jindal C. Reliability Measures of a Single-Unit System Under Preventive Maintenance and Degradation With Arbitrary Distributions of Random Variables, Journals of Reliability and Statistical Studies: 2014; 7:77-88. ISSN 0974-8024.
2. Liu R, Liu Z. Reliability Analysis of a One-Unit System With Finite Vacations, Management Science Industrial Engineering (MSIE) International Conference, 2011, 248-252.
3. Malik SC. Reliability Modeling and Profit Analysis of a Single-Unit System with Inspection by a Server who Appears and Disappears randomly, Journal of Pure and Applied Mathematika Sciences, 2008; LXVII(1-2):135-146.
4. Nakagawa T, Osaki S. Reliability Analysis of a One-Unit System with Un-repairable Spare Units and its Optimization Application, Quarterly Operations Research, 1976; 27(1):101-110.
5. Goel P, Singh J. Availability Analysis of A Thermal Power Plant Having Two Imperfect Switches, Proc. (Reviewed) of 2nd Annual Conference of ISITA. 1997.
6. Gupta P, Singh J, Singh IP. Availability Analysis of Soap Cakes production System – A Case Study, Proc. National Conference on Emerging Trends in Manufacturing System, SLIET, Longowal (Punjab). 2004, 283-295.
7. Kumar S, Goel P. Availability Analysis of Two Different Units System with a Standby Having Imperfect Switch Over Device in Banking Industry, Aryabhatta Journal of Mathematics & Informatics, ISSN: 0975-7139, 2014; 6(2):299-304.
8. Gupta VK. Analysis of a single unit system using a base state. Aryabhatta J of Maths & Info. 2011; 3(1):59-66.
9. Chaudhary Nidhi, Goel P, Kumar Surender. Developing the reliability model for availability and behavior analysis of a distillery using Regenerative Point Graphical Technique.: ISSN (Online): 2347-1697, 2013; 1(iv):26-40.
10. Sharma Sandeep P. Behavioral Analysis of Whole Grain Flour Mill Using RPGT. ISBN 978-93-325-4896-1, ICETESMA-15, 2015, 194-201.
11. Ritikesh, Goel. Availability Modeling of Single Unit System Subject to Degradation Post Repair After Complete Failure Using RPGT. ISSN 2347-8527, 2015.
12. Goyal Goel. Behavioral Analysis of Two Unit System with Preventive Maintenance and Degradation in One Unit after Complete Failure Using RPGT. ISSN 2347-8527. 2015; 4:190-197.