STOCHASTIC OPTIMIZATION AND RELIABILITY ANALYSIS OF MUSHROOM PLANT

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Abstract

In the present paper the reliability model for availability analysis of mushroom plant is developed in three sub-units like water pump, winter cold standby unit A.C., and packing machine. We assume a doctor of mushroom and workers are available who examines and repairs the elements as when we need. A mathematical model of the system is developed by using all these considerations. MTSF, Availability, server of busy period and expected number of servers visit of mushroom plant are determined with the assistance of RPGT. Graphs and tables are draw to depict the behavior of various parameters such as MTSF, Availability, server of busy period and expected number of servers visits and the effect of various parameters of the plant is analyzed when repair and failure rate both are vary and also when one of them is constant

Keywords: Availability, MTSF, RPGT, Straw.

1. Introduction

In Modern time, Production have vided variety from modest to complicate; So, mushroom manufacturer must have superior strategy of optimum accessibility for optimum grouping elements. In The era of competition, all mushroom manufacturer face challenges for assurance ideal manufacturing charges and nominal period to achieve implementation and reliability. Mushroom plants need extremely hard work for production [1]. For production of mushroom, we need storage rooms and in a storage room, wooden beds are required to put the bags of raw food of mushrooms on them. To prepare fertilize for mushroom we need wheat straw which is easily available everywhere. In alternate of wheat straw, we use rice straw, mustard straw, lentils straw and guar straw and other things which can be used in preparing of compost are bran, chicken beet, urea, gypsum and water as shown in figure 1. Bihar is top most state for producing mushroom. Mushroom contains components calcium, phosphorus, Potassium, iron and copper [2]. In winter season (sept. to march), two types of crops of mushroom are there. For increasing quality and production of mushroom Govt. has open mushroom centre at Solan collaborating with UNDP and the purpose of this centre is to provide technical knowledge about production and creating interest in farmers. The cost of this project is Rs. 1.26 crore with the following objectives: To make availability of quality spawn and compost, provide the latest production technologies for mushroom farming and provide marketing facilities for cultivation and distribution [3]. Govt. provide financial help to increase the production of mushroom in the form of subsidies and provide free training to farmers for production of mushroom. Nowadays, Mushroom production become popular in whole of the world [4].

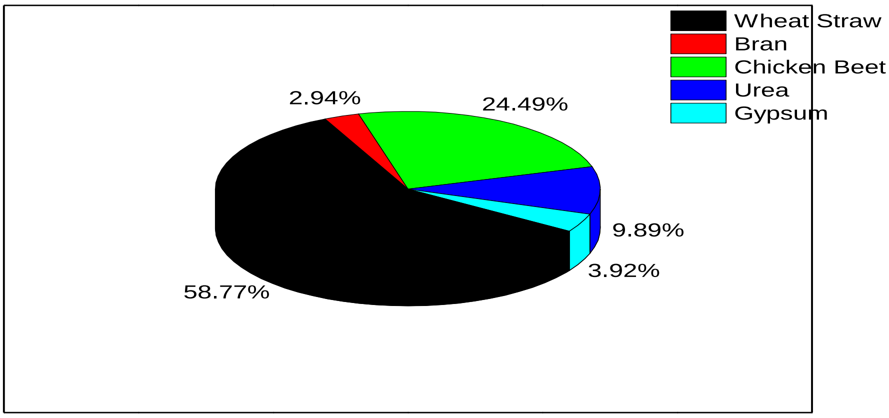


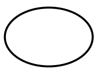
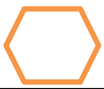
Figure 1. *Compost for Mushroom*

Approximately six days are required to prepare fertilize. After this procedure production of mushroom take approximate 20 days. For our discussion, we take three units like water pump, winter cold standby unit and packing machine. A Doctor is required for examining whole activity [5]. In winter, demand of mushroom increases due to the benefits of mushroom for our health like decreases the risk of cancer, promote lower cholesterol, protect brain health, provide the source of vitamin D and support a healthy immune system [13][14]. Keeping in view the defective and maintenance charges are fixed while fluctuate other charges, their influence on grouping activity elements is shown by illustrating tables and charts, precede by discussions [6][7].

2. Assumptions and Notations

- Facility of doctor of mushroom is always available.
- Workers are available as required as we need.
- Repairs and failures are not dependent numerically [15].
- After Repairing, system is fully worked as the new one.
- The system is discussed in steady-state situations.

Table 1. *Notations Used*

Symbol	Represent
	Working state
	Regenerative state
	Failed state
g_i	Repair rate
h_i	Failure rate

3. System Description

The sub-system and their working are described as given below

- **Water Pump (A):** Water Pump for watering mushroom.
- **Winter cold stand by unit A.C. (B):** Production of mushroom required low temperature. For this purpose, mushroom produces in winter and in summer for this purpose uses of A.C. Button mushroom requires 20^0-$28^0$for vegetative growth 12-18^0 C for reproductive growth [16].
- **Packing Machine** (M): Seiler are used for packing mushroom.

4. Transition Diagrams

By taking all the described notations and assumptions [8-9], the Transition Diagram of the system is shown in Figure 2.

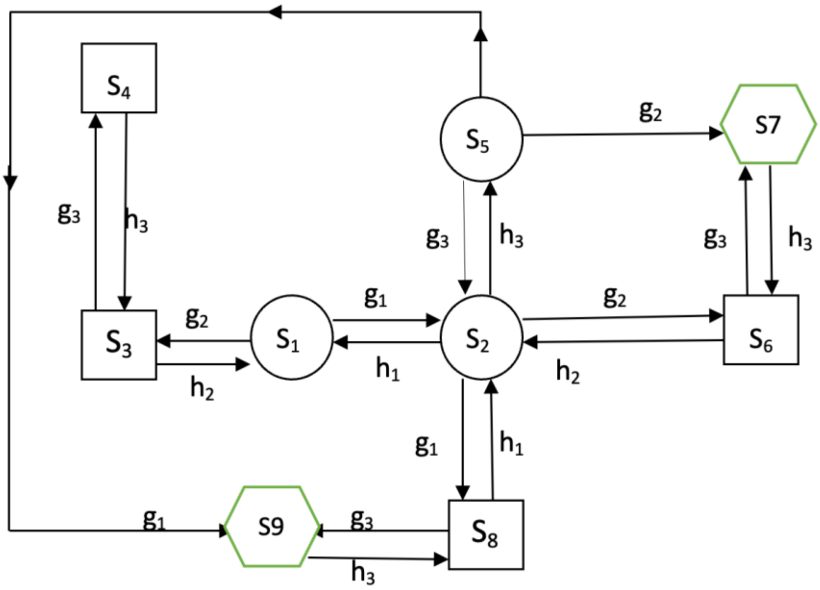


Figure 2. *Transition Diagram*

where,

S_1 = ABB′, S_2 = AbB′, S_3 = aBB′, S_4 =aBB′M,
S_5 = AbB′M, S_6 = abB′, S_7 = abB'M, S_8 = Abb′,
S_9 = Abb′M,

5. Model Description

A mushroom plant contains of following sub-units water pump(A), Winter (B) with cold standby unit B′, Packing Machine (M). Implication order to repair the elements and system are M >A> B. In the start the sub-unit is in state S_1[ABB′] where unit ‘B′, it’s cold standby sub-unit, unit ‘A’ and server are in good operational condition, hence the framework works in full volume. The cold redundant sub-unit when decent is shown in (′) which is prepared online directly with the assistance of a perfect switch over framework upon the disappointment of chief sub-unit ‘B’. From stage S_1 upon the disappointment of online unit ‘B’, disappointment rate of which is g_1, framework enters the stage S_2 [AbB′], here framework again works at full capacity as cold standby sub-unit is mode online. From stage S_2 upon repair of fizzled sub-unit, repair rate of which is h_1, framework again joins stage S_1. In stage S_1, if unit 'A' flops of which rate is g_2, upon its repair (repair rates h_2) over the framework come again into the stage S_1 while in stage S_3 if it fails with failure rate g_3, framework enters the stage S_4 [aBB'M] upon its repair (repair rate h_3) framework re-enters the stage S_3. In stage S_2 [AbB'] if online unit 'B' bombs at rates, the framework enters the stage S_8 [Abb'], upon repair of unit 'B' at rate h_1. The scheme come again into stage S_2 though in stage S_8 if the M unit fails (whose disappointment rate is g_3) structure joins the failed stage S_9 [Abb'M] upon its repair, behavior of the structure rejoins the stage S_8, where its resumes repairing the fizzled sub-unit 'B'. Also, in stage S_2 if unit 'A' fizzled at rate g_2, the framework takes stage S_6 [abB'] upon repair of unit 'A' structure rejoins the stage S_2 while in stage S_6. If associated fails at rate g_3, the framework takes the stage S_7 [abB'M], upon its reparation as it is assumed top priority, the structure rejoins the stage S_6. In state S_2 if the server failed the structure joins the stage S_5 [AbB'M], here the structure continues to work of full volume, as the attendant is given top priority in repair, so upon its repair the structure rejoins stage S_2, in stage S_5 if online sub-unit 'B' at rate g_1, the structure joins the stage S_9 and if the sub-unit 'A' then the structure joins the stage S_7.

Table 2. *Transition Probabilities*

$q_{i,j}(t)$	$p_{ij}=\int_0^\infty qij(t)dt$
$q_{1,2}(t) = g_1\, e^{-(g_1+g_2)t}$	$p_{1,2} = g_1/(g_1+g_2)$
$q_{1,3}(t) = g_2\, e^{-(g_1+g_2)t}$	$p_{1,3} = g_1/(g_1+g_2)$
$q_{2,1}(t) = h_1\, e^{-(g_1+g_2+g_3+h_1)t}$	$p_{2,1} = g_1/(g_1+g_2+g_3+h_1)$
$q_{2,5}(t) = g_3\, e^{-(g_1+g_2+g_3+h_1)t}$	$p_{2,5} = g_3/(g_1+g_2+g_3+h_1)$
$q_{2,6}(t) = g_2\, e^{-(g_1+g_2+g_3+h_1)t}$	$p_{2,6} = g_2/(g_1+g_2+g_3+h_1)$
$q_{2,8}(t) = g_1\, e^{-(g_1+g_2+g_3+h_1)t}$	$p_{2,8} = g_1/(g_1+g_2+g_3+h_1)$
$q_{3,1}(t) = h_2\, e^{-(h_2+g_3)t}$	$p_{3,1} = h_2/(h_2+g_3)$
$q_{3,4}(t) = g_3\, e^{-(h_2+g_3)t}$	$p_{3,4} = g_3/(h_2+g_3)$
$q_{4,3}(t) = h_3\, e^{-h_3 t}$	$p_{4,3} = 1$
$q_{5,2}(t) = h_3\, e^{-(g_1+g_2+h_3)t}$	$p_{5,2} = h_3/(g_1+g_2+h_3)$
$q_{5,7}(t) = g_2\, e^{-(g_1+g_2+h_3)t}$	$p_{5,7} = g_2/(g_1+g_2+h_3)$
$q_{5,9}(t) = g_1\, e^{-(g_1+g_2+h_3)t}$	$p_{5,9} = g_1/(g_1+g_2+h_3)$
$q_{6,2}(t) = h_2\, e^{-(g_3+h_2)t}$	$p_{6,2} = h_2/(g_3+h_2)$
$q_{6,7}(t) = g_3\, e^{-(g_3+h_2)t}$	$p_{6,7} = g_3/(g_3+h_2)$
$q_{7,6}(t) = h_3\, e^{-h_3 t}$	$p_{7,6} = 1$
$q_{8,2}(t) = h_1\, e^{-(g_3+h_1)t}$	$p_{8,2} = h_1/(h_1+g_3)$
$q_{8,9}(t) = g_3\, e^{-(g_3+h_1)t}$	$p_{8,9} = g_3/(h_1+g_3)$
$q_{9,8}(t) = h_3\, e^{-h_3 t}$	$p_{9,8} = 1$

Table 3. *Mean Sojourn Times*

$\boldsymbol{R_i}(t)$	$\mu_i=\int_0^\infty \boldsymbol{R_i}(t)dt$
$R_1(t) = e^{-(g_1+g_2)t}$	$\mu_1 = 1/(g_1+g_2)$
$R_2(t) = e^{-(g_1+g_2+g_3+h_1)t}$	$\mu_2 = 1/(g_1+g_2+g_3+h_1)$
$R_3(t) = e^{-(h_2+g_3)t}$	$\mu_3 = 1/(h_2+g_3)$
$R_4(t) = e^{-h_3 t}$	$\mu_4 = 1/h_3$
$R_5(t) = e^{-(g_1+g_2+h_3)t}$	$\mu_5 = 1/(g_1+g_2+h_3)$
$R_6(t) = e^{-(g_3+h_2)t}$	$\mu_6 = 1/(g_3+h_2)$
$R_7(t) = e^{-h_3 t}$	$\mu_7 = 1/h_3$
$R_8(t) = e^{-(h_1+g_3)t}$	$\mu_8 = 1/(h_1+g_3)$
$R_9(t) = e^{-h_3 t}$	$\mu_9 = 1/h_3$

5.1 Evaluation of Path Probabilities

Applying RPGT and use '1' as initial-stage of the structure, we detect all transition possibilities aspects of all accessible stages from initial stage 'ξ' = '1' [10] [11].

We will discover probabilities after state '1' to various vertices which are defined as follows:

$V_{1,1} = 1$ (Verified)

$V_{1,2} = (1, 2)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]$

$= p_{1,2}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}]$

$V_{1,3} = (1, 3)/\{1 - (3, 4, 3)\}$

$= p_{1,3}/(1 - p_{3,4}p_{4,3})$

$V_{1,4} = (1, 3, 4)/\{1 - (3, 4, 3)\}$

$= p_{1,3}p_{3,4}/(1 - p_{3,4}p_{4,3})$

$V_{1,5} = (1, 2, 5)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]$

$= p_{1,2}p_{2,5}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}]$

$V_{1,6} = (1, 2, 6)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]\{1 - (6, 7, 6)\}$

$= (1, 2, 5, 7, 6)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]\{1 - (6, 7, 6)\}$

$= p_{1,2}p_{2,6}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}](1 - p_{6,7}p_{7,6})$

$= p_{1,2}p_{2,5}p_{5,7}p_{7,6}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}](1 - p_{6,7}p_{7,6})$

$V_{1,7} = (1, 2, 5, 7)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]\{1 - (8, 6, 8)\}$

$= (1, 2, 6, 7)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1-(1,7,1)/\{1-(7,8,7)\}]\{1-(5,6,5)\}$

$= p_{1,2}p_{2,5}p_{5,7}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}](1 - p_{7,6}p_{6,7})$

$= p_{1,2}p_{2,6}p_{6,7}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}]$
$(1 - p_{6,7}p_{7,6})$

$V_{1,8} = (1, 2, 8)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]\{1 - (8, 9, 8)\}$

$= (1, 2, 8, 9, 8)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]\{1 - (8, 9, 8)\}$

$= p_{1,2}p_{2,8}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}](1 - p_{8,9}p_{9,8})$

$= p_{1,2}p_{2,5}p_{5,9}p_{9,8}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}](1 - p_{8,9}p_{9,8})$

$V_{1,9} = (1, 2, 5, 9)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]\{1 - (9, 8, 7)\}$

$= (1, 2, 8, 9)/\{1 - (2, 5, 2)\}[1 - (2, 6, 2)/\{1 - (6, 7, 6)\}][1 - (2, 8, 2)/\{1 - (8, 9, 8)\}]\{1 - (9, 8, 9)\}$

$= p_{1,2}p_{2,5}p_{5,9}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}](1 - p_{9,8}p_{8,9})$

$= p_{1,2}p_{2,8}p_{8,9}/(1 - p_{2,5}p_{5,2})[1 - \{(p_{2,6}p_{6,2}/(1 - p_{6,7}p_{7,6})\}][1 - \{(p_{2,8}p_{8,2}/(1 - p_{8,9}p_{9,8})\}]$
$(1 - p_{9,8}p_{8,9})$

Transition stage possibilities from base stage '2' are

$V_{2,1} = (2, 1)/[\{1 - (1, 3, 1)\}/\{1 - (3, 4, 3)\}]$

$= p_{2,1}/\{(1 - p_{1,3}p_{3,1})/(1 - p_{3,4}p_{4,3})\}$

$V_{2,2} = 1$

$V_{2,3} = (2, 1, 3)/[\{1 - (1, 3, 1)\}/\{1 - (3, 4, 3)\}]\{1 - (3, 4, 3)\}$

$= p_{2,1}p_{1,3}/[\{(1 - p_{1,3}p_{3,1})/(1 - p_{3,4}p_{4,3})\}(1 - p_{3,4}p_{4,3})]$

$V_{2,4} = (2, 1, 3, 4)/[\{1 - (1, 3, 1)\}/\{1 - (3, 4, 3)\}]\{1 - (3, 4, 3)\}$

$= p_{2,1}p_{1,3}p_{3,4}/[\{(1 - p_{1,3}p_{3,1})/(1 - p_{3,4}p_{4,3})\}(1 - p_{3,4}p_{4,3})]$

$V_{2,5} = (2, 5)$

$= p_{2,5}$

$V_{2,6} = (2, 6)/\{1 - (6, 7, 6)\} + (2, 5, 7, 6)$

$= p_{2,6}/(1 - p_{6,7}p_{7,6}) + p_{2,5}p_{5,7}p_{7,6}$

$V_{2,7} = (2, 5, 7)/[\{1 - (7, 6, 7)\}/\{1 - (6, 2, 6)\}] + (2, 6, 7)$

$= p_{2,5}p_{5,7}/\{(1 - p_{6,7}p_{7,6})/(1 - p_{6,2}p_{2,6}) + p_{2,6}p_{6,7}$

$V_{2,8} = (2, 8)/\{1 - (8, 9, 8)\} + (2, 5, 9, 8)$

$= p_{2,8}/(1 - p_{8,9}p_{9,8}) + p_{2,5}p_{5,9}p_{9,8}$

$V_{2,9} = (2, 8, 9)/\{1 - (8, 9, 8)\} + (2, 5, 9)$

$= p_{2,8}p_{8,9}/(1 - p_{8,9}p_{9,8}) + p_{2,5}p_{5,9}$

6. Modeling System Parameters by using RPGT

6.1. Mean time to system failure (T_0)

Regenerative working stages [12], where the framework can transit (base stage '2'), earlier incoming into failed stage are: 'i' = 1, 2, 5 attractive 'ξ' = '1' [12]

$T_0 = (V_{1,1}\,\mu_1 + V_{1,2}\,\mu_2 + V_{1,5}\,\mu_5) / \{1 - (1, 2, 1)\}$

6.2 Availability of the system (A_0)

Regenerative stages, where the framework is accessible are 'i' = 1, 2, 5 attractive 'ξ' = '1' whole fraction of time for which the framework is accessible is assumed by

$A_0 = (V_{2,1}\,\mu_1 + V_{2,2}\,\mu_2 + V_{2,5}\,\mu_5)/Z_1$

$\therefore Z = V_{1,1}\,\mu_1 + V_{1,2}\,\mu_2 + V_{1,3}\,\mu_3 + V_{1,4}\,\mu_4 + V_{1,5}\,\mu_5 + V_{1,6}\,\mu_6 + V_{1,7}\,\mu_7 + V_{1,8}\,\mu_8 + V_{1,9}\,\mu_9$

$\therefore Z_1 = V_{2,1}\,\mu_1 + V_{2,2}\,\mu_2 + V_{2,3}\,\mu_3 + V_{2,4}\,\mu_4 + V_{2,5}\,\mu_5 + V_{2,6}\,\mu_6 + V_{2,7}\,\mu_7 + V_{2,8}\,\mu_8 + V_{2,9}\,\mu_9$

6.3 Server of busy period (B_0)

Regenerative stages where repairman is busy are $2 \leq j \leq 9$, whole fraction of time for which server remains eventful is by equation:

$B_0 = (V_{1,2}\,\mu_2 + V_{1,3}\,\mu_3 + V_{1,4}\,\mu_4 + V_{1,5}\,\mu_5 + V_{1,6}\,\mu_6 + V_{1,7}\,\mu_7 + V_{1,8}\,\mu_8 + V_{1,9}\,\mu_9)/D$

$= 1 - (\mu_1 / D)$

6.4 Expected number of server visit's (V_0)

Regenerative stages, where repair man do this job are j = 2, 5 number of visit by repair man is given by:

$V_0 = (V_{1,2} + V_{1,5}) / D$

7. Behavior Analysis (Particular Cases: - $h_i = h$; $g_i = g$)

7.1 Mean Time to System Failure (MTSF)

By taking values of repair and failure rates as g_i's and h_i's, Value of MTSF is calculated by RPGT

Table 4. *MTSF (T0)*

	h = .55	h = .65	h = .75
g = .15	5.32	5.25	5.05
g = .25	4.49	4.42	4.37
g = .35	3.53	3.49	3.42

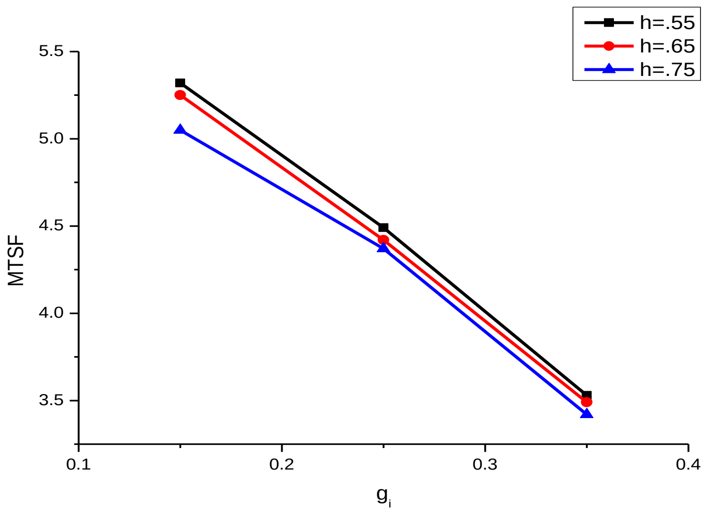


Figure 3. *MTSF*

From the above Figure 3 and Table 4 demonstrations the performance of MTSF Vs Repair rate of the sub-unit of the framework for various values of the disappointment rate. From the above Figure 3 one can determine that MTSF is increasing which must be so once the repair rate amassed and decreases when the disappointment rate rises which should be so in practical situations.

7.2 Availability of the system (A_0):

Table 5: *Availability of the system*

	h = .55	h = .65	h = .75
g = .15	.84	.88	.93
g = .25	.72	.75	.79
g = .35	.62	.67	.72

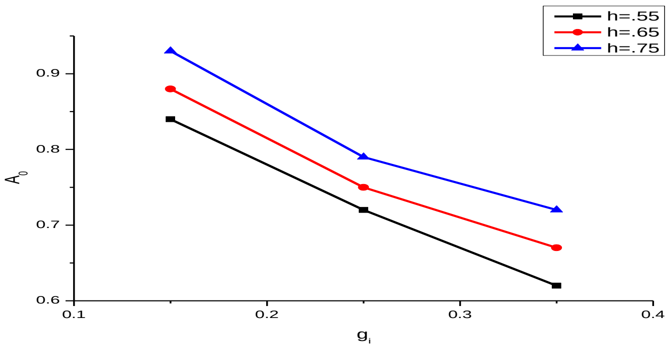


Figure 4: *Availability of the system*

The above Table 5 shows that the Availability is increasing when the repair rate is increasing and decrease with the rise in disappointment rate, which ought to be actually.

7.3 Server of the busy period (B_0):

Table 6: *Server of the busy period*

	h = .50	h = .60	h = .70
g = .15	.65	.62	.59
g = .25	.69	.65	.62
g = .35	.74	.69	.67

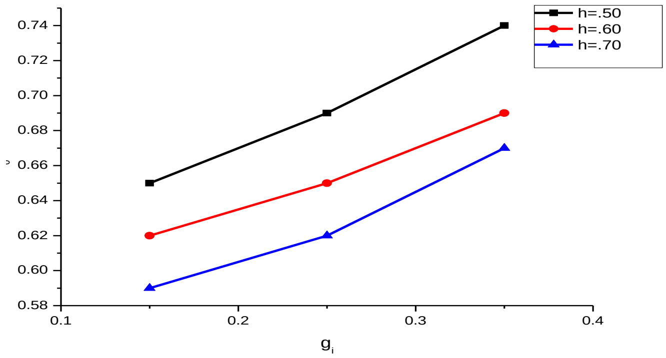


Figure 5: *Server of the busy period*

It can be concluded from the above Figure 5 that the values of server of busy period shows the expected trend for various values of disappointment rate, as server of busy period decreases with the rise in the values of repair rate.

7.4 Expected number of server visits (V_0):

Table 7: *Expected number of server visits*

	h = .55	h = .65	h = .75
g = .15	.34	.38	.42
g = .25	.39	.44	.48
g = .35	.43	.48	.52

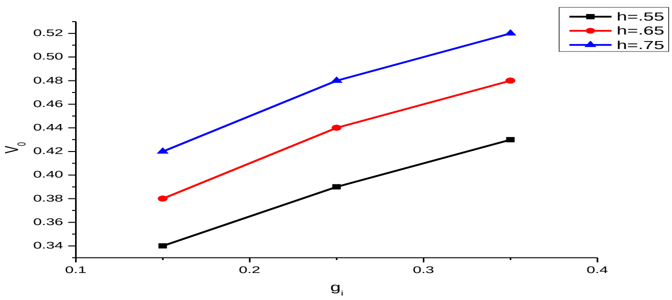


Figure 6: *Expected number of server visits*

It can be concluded from the above Figure 6 and Table 7 that the values of Expected number of server visits demonstrations the expected trend for various values of disappointment rate, as Expected number of server visits increases with the rise in the values of repair rate.

8. Effect of Repair Rates on System (Keeping Failure Rates Fixed)

8.1 Effect on MTSF (T0) parameters

Table 8: *MTSF*

h_i	h_1	h_2	h_3
0.75	6.58	6.58	6.58
0.85	6.58	6.58	6.58
0.95	6.58	6.58	6.58

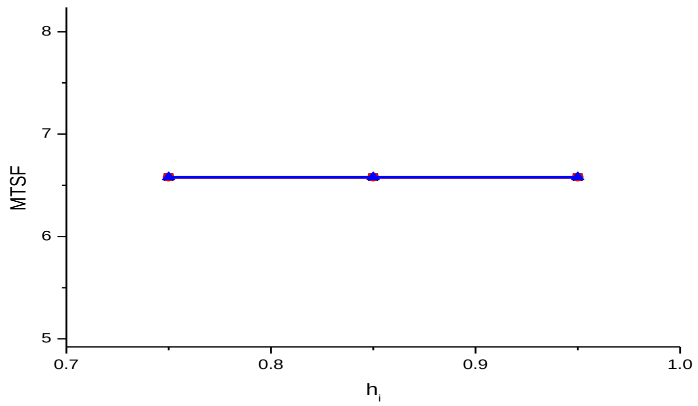


Figure 7: *MTSF*

From the above Table 8 in affecting in rows, from the 1st row it is understood that, MTSF is similar for secure and server. From the subsequent row it is determined that MTSF is constant when repair rate of server is increase. On associating the columns, it is experimental that MTSF constant at higher rates as growing repair rate of server. From the Figure 7, it is determined that MTSF is constant in repair rates.

8.2 Effect on Availability of the system (A_0)

Table 9: *Availability of the system*

h_i	h_1	h_2	h_3
0.75	0.925	0.920	0.915
0.85	0.930	0.925	0.920
0.95	0.935	0.930	0.925

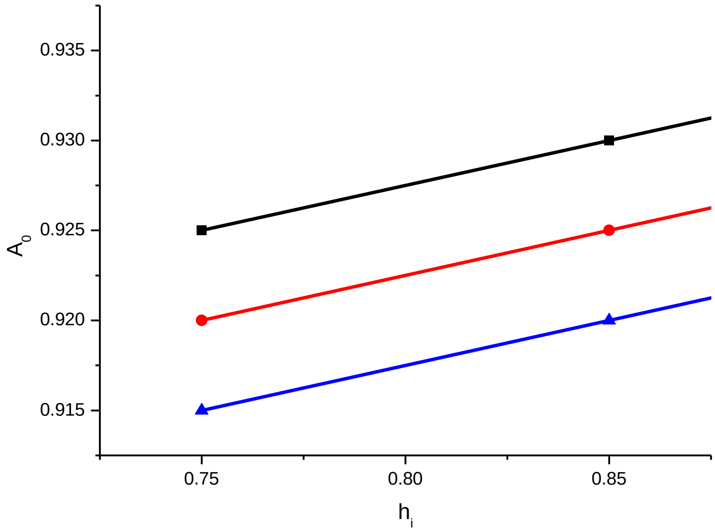


Figure 8: *Availability of the system*

From the Figure 8 and Table 9, it is realized there is not much implication change in value of Availability of the system parallel to rise in repair rates of sub-units and server. However, from the Figure 8 and Table 9 it is determined that to have extreme value of Availability of the system repair rate of server must be supreme.

8.3 Effect on Server of the busy period (B_0)

Table 10. *Server of the busy period*

h_i	h_1	h_2	h_3
0.75	0.218	0.224	0.243
0.85	0.211	0.218	0.229
0.95	0.206	0.213	0.218

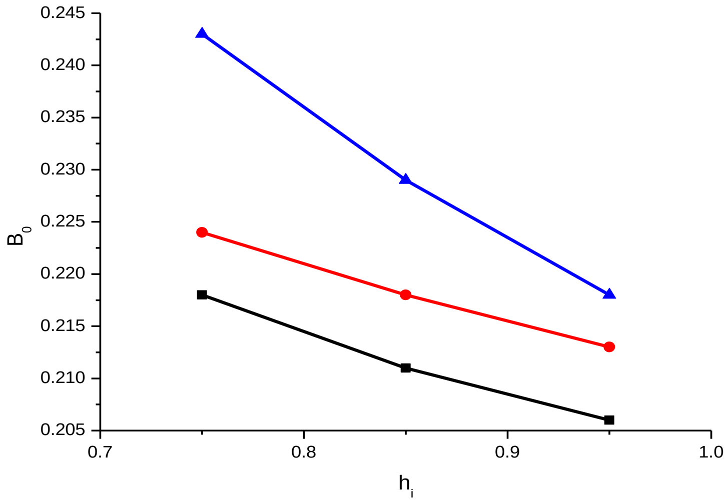


Figure 9. *Server of the busy period*

Observing in columns of Table 10, one sees that Server of the busy period reductions with the rise in repair rates which is applied but it decreases less, increasing the comparative repair rate of sub-unit. Same is the opinion while examining the values in rows.

8.4 Effect on Expected number of server visits (V_0)

Table 11. *Expected number of server visits*

h_i	h_1	h_2	h_3
0.75	0.212	0.227	0.241
0.85	0.201	0.212	0.226
0.95	0.185	0.202	0.212

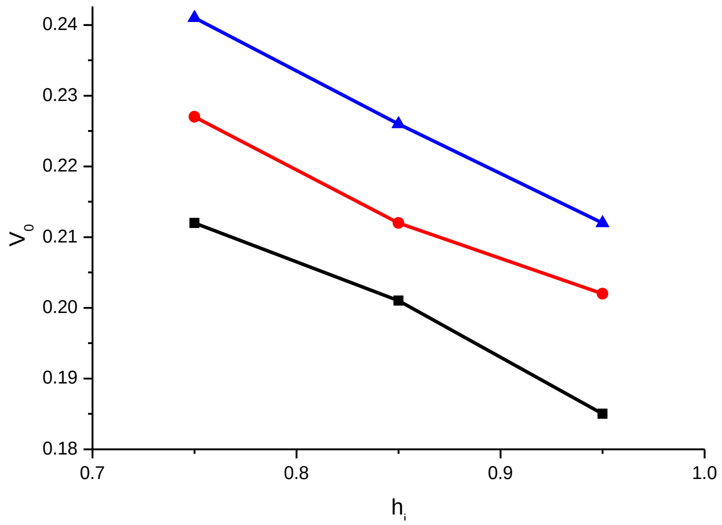


Figure 10. *Expected number of server visits*

From the Figure 11 and Table 10 it is seen that cost of Expected number of server visits is optimal repair rate of sub-unit 'is 0.95 and associating the rates it is seen there is no significant, hence to keep assessment of Expected number of server visits lowest for minimum cost sub-unit need more care in terms of maintenance facilities.

9. Effect of Change of Failure Rates (Keeping Repair Rate Fixed)

9.1 MTSF

Table 12. MTSF

g_i	g_1	g_2	g_3
0.15	3.27	3.35	3.42
0.25	3.19	3.27	3.34
0.35	3.13	3.19	3.27

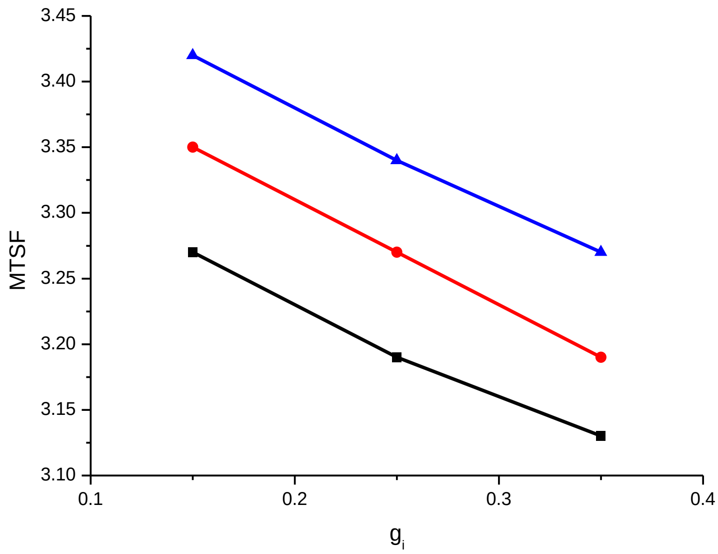


Figure 11. MTSF

For an ideal structure value of MTSF must be biggest possible from the Figure 11 and Table 12. It is determined that value of MTSF is supreme when disappointment rates of all sub-units and server are least and go as reducing as the disappointment rates of units rise. But value of MTSF decreases more quickly with rise in failure rate of first sub-unit over another sub-units, hence necessity be taken care of in terms of disappointment rate over another sub-units and server for greatest value of MTSF.

9.2 Availability of the system(A_0)

Table 13. *Availability of the system*

g_i	g_1	g_2	g_3
0.15	0.927	0.948	0.963
0.25	0.907	0.927	0.945
0.35	0.886	0.906	0.927

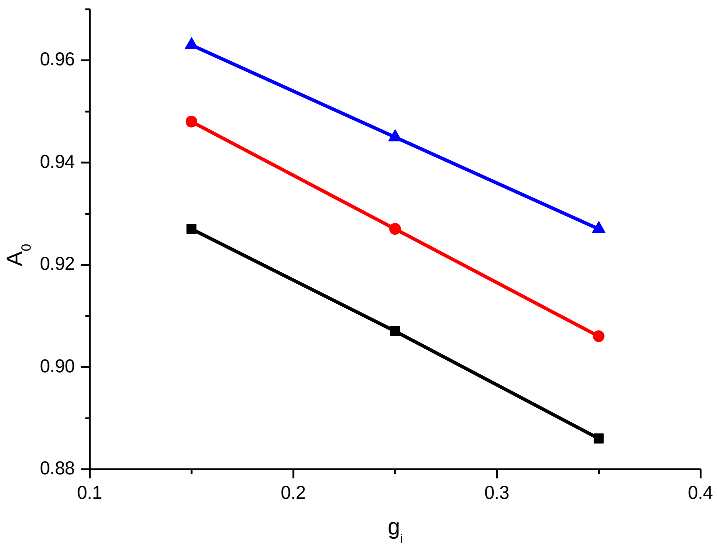


Figure 12. *Availability of the system*

An ideal structure value of Availability of the system ought be supreme from the 1st row of above Table 13 and Figure 12 , it is understood that Availability of the system is best when disappointment rate of sub-units and server are smallest on associating the columns Availability of the system decreases more quickly with the rise in disappointment of units, hence Availability of the system value of Availability of the system biggest, it is optional that that first sub-unit needs more care for upkeep facilities.

9.3 Server of the busy period (B_0)

Table 14. *Server of the busy period*

g_i	g_1	g_2	g_3
0.15	0.246	0.205	0.179
0.25	0.289	0.246	0.205
0.35	0.321	0.287	0.246

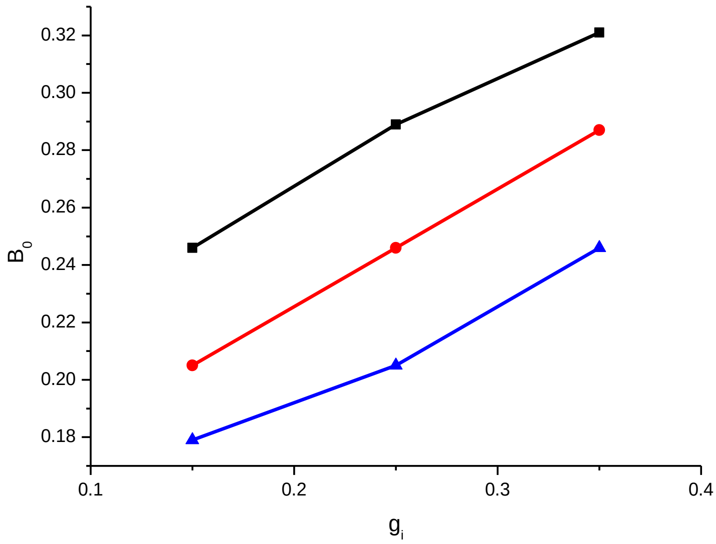


Figure 13. *Server of the busy period*

To do study with esteem to value of Server of the busy period in the exceeding Table 14, it is decent to keep value of Server of the busy period minimum, on associating the columns, it is experimental that Server of the busy period have similar values for disappointment rate of server in assessment to units first and second unit.

9.4 Expected number of server visits (V_0)

Table 15. *Expected number of server visits*

g_i	g_1	g_2	g_3
0.15	0.312	0.299	0.275
0.25	0.319	0.312	0.301
0.35	0.325	0.321	0.312

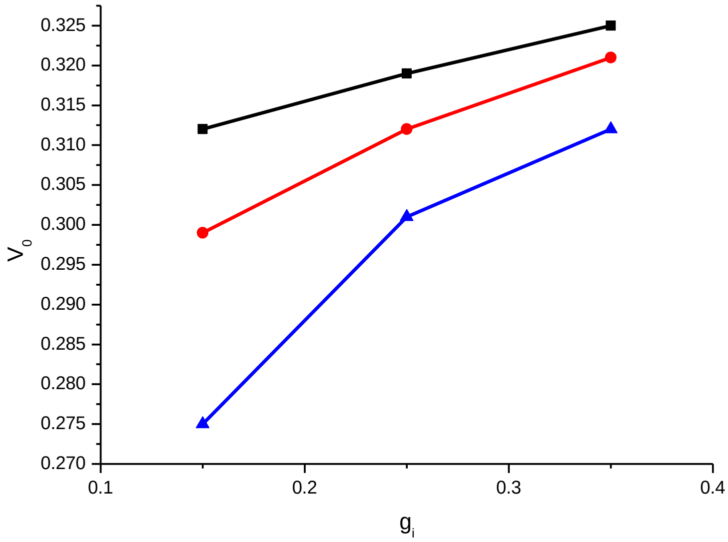


Figure 14. *Expected number of server visits*

A structure will be named Table 15 free if the Expected number of server visits are small foam the table and Figure 14, it is optional that for small value of Expected number of server visits, disappointment rates of sub-units and server to be kept smallest i.e., sub-units and server must be best in enterprise and quality, however value of Expected number of server visits rise proportional less in assessment to increasing disappointment rate of server. Thus, online sub-units need more upkeep the whole server. In all to keep reduced value of cost and that V_0, disappointment rates of sub-units and server to be kept small.

10. Results

- Value of MTSF(T_0) is decreased with increasing of repair and failure rate and T_0 is fix when failure rate is fixed and T_0 is increased when repair rate is fixed.
- Availability of the system(A_0) is increased with increasing of failure rate and decreased with increasing of repair rate and when failure rate is fixing value of A_0 is increased with the value of repair rate and in case when repair rate is fixing value of A_0 is decreased with the value of rising failure rate.
- Server of busy period(B_0) is increased with increased of repair rate and decreased with the increasing of failure rate and when failure rate is fixed value of B_0 is decreased with the increasing of repair rate and in case if repair rate is fixed then value of B_0 is increased with the increasing of failure rate.
- Expected number of server visit(V_0) is increased with the increasing of repair and failure rate and when failure rate is fixed the value of V_0 is decreased with increasing of repair rate and in case if repair rate is fixed then value of V_0 is fixed with the increasing of failure rate.

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