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International Journal of Research in Engineering and Applied Sciences(IJREAS)
Available online at http://euroasiapub.org/journals.php
Vol. 12 Issue 05, May - 2022
ISSN(O): 2249-3905, ISSN(P) : 2349-6525 | Impact Factor: 8.202 |
Thomson Reuters ID: L-5236-2015

Mathematical Modelling and Behaviour Analysis of the Kohinoor Basmati Rice Plant Using RPGT

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DOI: 10.6084/m9.figshare.19811845

Abstract: -There are four subsystems in the Kohinoor Basmati Rice Plant. Cleaning, Husking, Separation, and Elevator are the four subsystems that make up the rice plant. Cleaning is divided into two sections. With the use of RPGT, the availability of rice plants is determined, as well as the accessibility of rice plant arrangements for various maintenance and failure rates of subsystems. Specific instances are created to examine the impact of failure/repair rates on MTSF, availability, and busy period server availability.

Keywords: RPGT, Rice Porridge, Availability

Introduction

Rice plant is the most established and the biggest agro handling industry. We describe a Kohinoor Rice plant which comprises of four subsystems. The Rice Plant basically comprises of four subsystems specifically Cleaning, Husking, Separation, and Elevator. Cleaning has two sub-units. At first cleaning dries the crud material (paddy) and places it into the husker. Husking is utilized to strip off husk from the paddy. Separation isolates rice and husk. At that point polishing shines the rice for example it strip off bran from the rice. Elevator is utilized to review the rice for example to isolate the long grain and short grain. Then with the assistance of whitening black rice are isolated from evaluated rice. Availability of rice plant is determined with the assistance of RPGT and accessibility of the arrangement of rice plant for various values of repair and disappointment rates of frameworks is additionally determined. Rajbala & Kumar [2021] discussed about an article on the system reliability and availability analysis using RPGT-A general approach. Kumar and Garg [2019] have discussed the reliability technology theory and its applications. Kumar et al. [2018] have studied behaviour analysis of a bread making system. Kumar et. al. [2019] analyzed sensitivity analysis of a cold standby framework with priority for preventive maintenance consist two identical units with server failure utilizing RPGT. Rajbala, et al. [2019] have studied the system modeling and analysis: a case study EAEP manufacturing plant. Kumar et al. [2017] have studied behavior analysis in the urea fertilizer industry. Kumar et al. [2017] have examined the mathematical modeling & profit analysis of an edible oil refinery plant. Kumar et al. [2019] studied mathematical modeling & behavioral analysis of a washing unit in paper mill. Kumar et. al. [2018] paper analyzed sensitivity analysis of 3:4:: good system plant. Kumari et al. [2021] studied the constrained problems using PSO. Kumari et al. [2021] discussed the profit analysis of an agriculture thresher plant in steady state using RPGT.

Notations

A, B, C, D – Working state

y_i/x_i – respective mean constant repair/failure rates.; i=1,2,3,4

Assumptions

Failure and repairs events are all statistically independent.

Repair unit is as good as new one.

State Transitions Diagrams: The state S_2, S_6, S_{10} are the working states, S_3, S_4, S_5, S_7, S_8, S_9, S_{11}, S_{12}, S_{13}, S_{14} are failed states. Whereas, S_2 is taken as the base state.

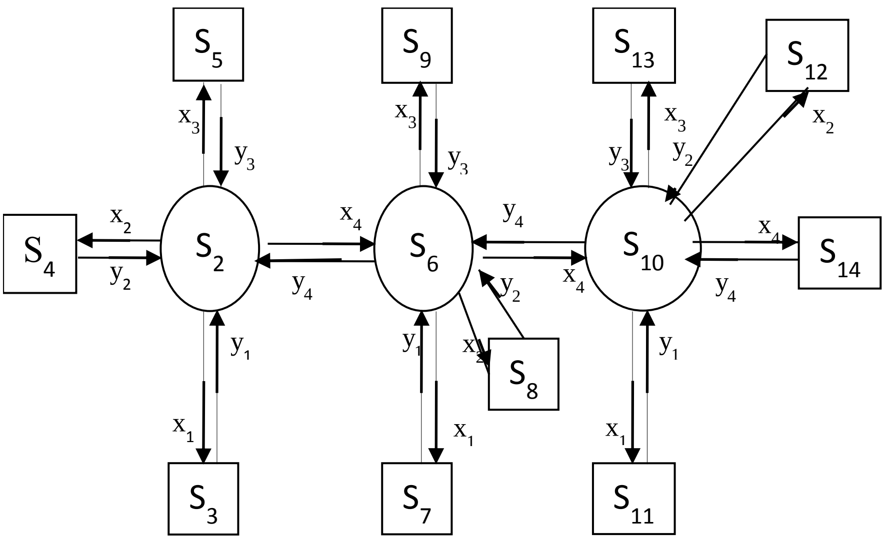

Figure 4.11: Transition Diagram of the system

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S_2 = ABCD, S_3 =aBCD, S_4 =AbCD, S_5 =ABcD,

S_6 =ABCD$_1$, S_7 =aBCD$_1$, S_8 =AbCD$_1$, S_9 =ABcD$_1$,

S_{10} = ABCd$_2$, S_{11} =aBCD$_2$, S_{12} = AbCD$_2$, S_{13} = ABcD$_2$, S_{14} = ABCd

Transition Probability & Mean Sojourn Times

$q_{i,j}(t)$: Probability distribution function from i to j. pi,j: Transition probability from i to j.

$p_{i,j} = q_{i,j}*(0)$; where * designate Laplace transform.

Table 1: Transition Probabilities

$q_{i,j}(t)$	$P_{ij} = q^*_{i,j}(0)$
$q_{2,i}(t) = x_j e^{-(x_1+x_2+x_3+x_4)t}$; i =2,3,4,5 & j = 1,2,3,4	$p_{2,i} = x_j/(x_1+x_2+x_3+x_4)$ i =2,3,4,5 & j = 1,2,3,4
$q_{3,2} = y_1 e^{-y_1 t}$	$p_{3,2} = 1$
$q_{4,2} = y_2 e^{-y_2 t}$	$p_{4,2} = 1$
$q_{5,2} = y_3 e^{-y_3 t}$	$p_{5,2} = 1$
$q_{6,2}(t) = y_4 e^{-(x_1+x_2+x_3+x_4+y_4)t}$ $q_{6,i}(t) = x_j e^{-(x_1+x_2+x_3+x_4+y_4)t}$ i =6,7,8,9 & j = 1,2,3,4	$p_{6,2} = y_4/(x_1+x_2+x_3+x_4+y_4)$ $p_{6,i} = x_j/(x_1+x_2+x_3+x_4+y_4)$ i =6,7,8,9 & j = 1,2,3,4
$q_{7,6} = y_1 e^{-y_1 t}$	$p_{7,6} = 1$
$q_{8,6} = y_2 e^{-y_2 t}$	$p_{8,6} = 1$
$q_{9,6} = y_3 e^{-y_3 t}$	$p_{9,6} = 1$
$q_{10,6}(t) = y_4 e^{-(x_1+x_2+x_3+x_4+y)t}$ $q_{10,i}(t) = x_j e^{-(x_1+x_2+x+x_4+y_4)t}$ i =10,11,12,13 & j = 1,2,3,4	$p_{10,6} = y_4/(x_1+x_2+x_3+x_4+y_4)$ $p_{10,i} = x_j/(x_1+x_2+x_3+x_4+y_4)$ i =10,11,12,13 & j = 1,2,3,4
$q_{11,10} = y_1 e^{-y_1 t}$	$p_{11,10} = 1$
$q_{12,10} = y_2 e^{-y_2 t}$	$p_{12,10} = 1$
$q_{13,10} = y_3 e^{-y_3 t}$	$p_{13,10} = 1$
$q_{14,10} = y_4 e^{-y_4 t}$	$p_{14,10} = 1$

Table 2: Mean Sojourn Times

$R_i(t)$	$\mu_i = R_i^*(0)$
$R_2(t) = e^{-(x_1+x_2+x_3+x_4)t}$	$\mu_2 = 1/(x_1+x_2+x_3+x_4)$
$R_3(t) = e^{-y_1 t}$	$\mu_3 = 1/y_1$
$R_4(t) = e^{-y_2 t}$	$\mu_4 = 1/y_2$
$R_5(t) = e^{-y_3 t}$	$\mu_5 = 1/y_3$
$R_6(t) = e^{-(x_1+x_2+x_3+x_4+y_4)t}$	$\mu_6 = 1/(x_1+x_2+x_3+x_4+y_4)$

$R_7(t)= e^{-y_1 t}$	$\mu_7= 1/y_1$
$R_8(t)= e^{-y_2 t}$	$\mu_8= 1/y_2$
$R_9(t)= e^{-y_3 t}$	$\mu_9= 1/y_3$
R_{10}(t)= $e^{-(x_1+x_2+x_3+x_4+y_4)t}$	$\mu_{10}= 1/(x_1+x_2+x_3+x_4+y_4)$
$R_{11}(t)= e^{-y_1 t}$	$\mu_{11}= 1/y_1$
$R_{12}(t)= e^{-y_2 t}$	$\mu_{12}= 1/y_2$
$R_{13}(t)= e^{-y_3 t}$	$\mu_{13}= 1/y_3$
$R_{14}(t)= e^{-y_4 t}$	$\mu_{14}= 1/y_4$

Evaluation of Path Probabilities: - Applying RPGT and using '2' as initial-state offramework as under: The transition probability factors of all reachable states from base state 'ξ' = '10' are:

$V_{2,2} = 1$

$V_{2,i} = (2, i) = p_{2,i}$

where i = 3, 4, 5

$V_{2,6}$ = …..Continuous

Probabilities from state '10' to different vertices are given as

$V_{10,2} = p_{10,6}\, p_{10,2}/ (1- p_{6,7}\, p_{7,6}) (1- p_{6,8}\, p_{8,6}) (1- p_{6,9}\, p_{9,6}) (1- p_{2,3}\, p_{3,2}) (1- p_{2,4}\, p_{4,2}) (1- p_{2,5}\, p_{5,2}) \{(1- p_{6,2} p_{2,6})/ (1- p_{2,3}\, p_{3,2}) (1- p_{2,4}\, p_{4,2}) (1- p_{2,5}\, p_{5,2})\}$

$V_{10,i}$ = …..Continuous

Measures of plant effectiveness

The MTSF and other measures of the plant are evaluated under steady state condition and utilizing S2 is the base state.

MTSF(T_0): Regenerative un-failed states to which the frameworkcontainer transit(initial state '2'), afore entering any unsuccessful state are: 'i' = 2, 6, 10.

$T_0 = (V_{2,2}\, \mu_2 + V_{2,6}\, \mu_6 + V_{2,10}\, \mu_{10})/\{1- V(2, 6, 2)\}(1-p_{2,6}\, p_{6,2})$

AOS(A_0): Regenerative states at which the framework is obtainable are 'j' = 2,6,10&reformative states are 'i' = 2 to 14.

$A_0 = (V_{10,2}\, \mu_2 + V_{10,6}\, \mu_6 + V_{10,10}\, \mu_{10})/D$

Where $D = V_{2,I}\, \mu_i\,;\ 2 \le i \le 14$

BPOS: Regenerative states where attendant is hectic are j = 3 to 14,reformative states are 'i'

= 2 to 14.

$B_0 = \left[\sum_j V_{\xi,j}\,, n_j\right] \div \left[\sum_i V_{\xi,i}\,, \mu_i^1\right]$

$B_0 = (V_{2,j}\mu_j)/D$

$3 \leq j \leq 14$

ENOIR: Regenerative states where repairman visit is j = 3 to 14 reformative states are i = 2 to 14.

$V_0 = \left[\sum_j V_{\xi,j}\right] \div \left[\sum_i V_{\xi,i}\,, \mu_i^1\right]$

$V_0 = (V_{2,j})/ D$

$3 \leq j \leq 14.$

Particular Cases: - $y_i = y\ (0 \leq i \leq 4)$, $x_i = x\ (0 \leq i \leq 4)$; r= x, s = y

Table3: MTSF (T_0)

	y = .55	y = .65	y = .75
x = .15	3.97	3.91	3.80
x = .25	2.77	2.64	2.58
x= .35	1.63	1.58	1.53

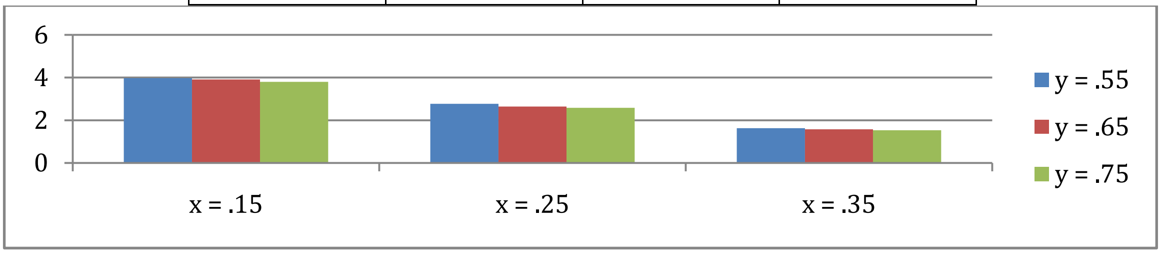

Fig. 2: MTSF

Fig. 2, presumes that MTSF diminishes all more rapidly with an increment in disappointment rates of units. MTSF isn't set up with development in repair rate, and a disappointment rate is something similar.

AOS (A_0):

Table4: AOS

	y = .55	y = .65	y = .75
x = .15	.55	.69	.62
x = .25	.37	.40	.45
x = .35	.20	.39	.40

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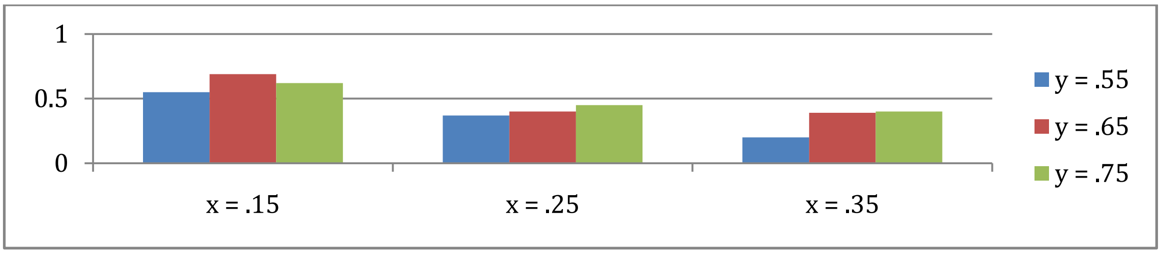

Fig. 3: AOS

Fig. 3 shows the value of A_0 expanding with the expansion in the unit's maintenance rates and decrease with the increment in disappointment rates of unit.

BPOS (B_0):

Table 5: BPOS

	y = .55	y = .65	y = .75
x = .15	.44	.39	.35
x = .25	.64	.58	.52
x = .35	.80	.74	.66

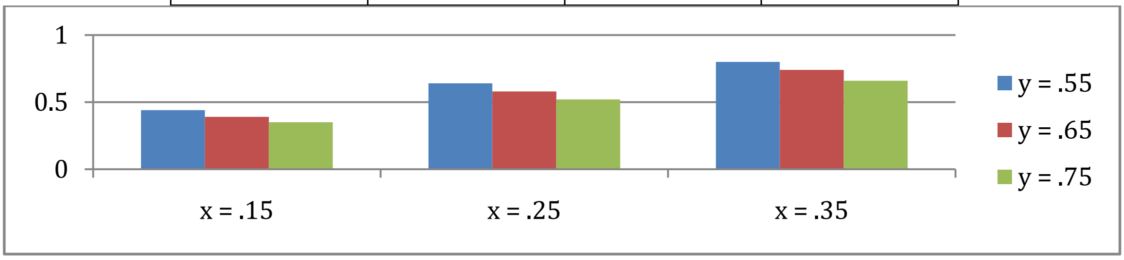

Fig. 4: BPOS

From the table 5, it is presumed that the BPOS decline as the maintenance rates of units increase and once seen that a first row the last column is the least worth of the units.

ENOIR (V_0): -

Table 6: ENOIR

	y = .55	y = .65	y = .75
x = .15	.23	.27	.31
x = .25	.25	.30	.34
x = .35	.32	.39	.44

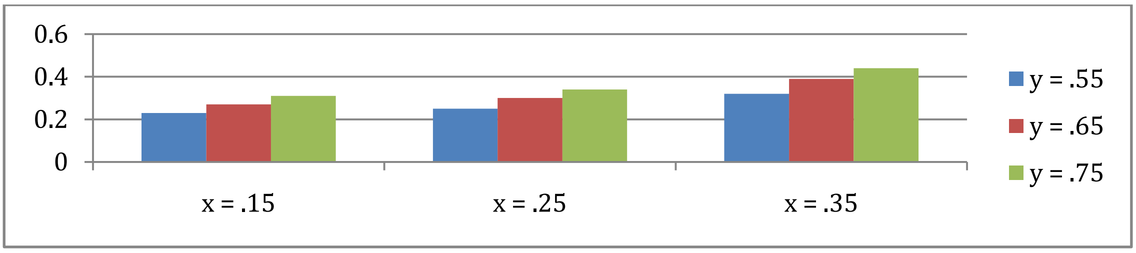

Fig. 5: ENOIR

It inferred that ENOIR is straightforwardly relative to repair and disappointment rates of subsystems.

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