Stochastic Modelling and Computational Sciences

MATHEMATICAL MODELING AND AVAILABILITY ANALYSIS OF A BISCUIT PLANT

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ABSTRACT
This study uses RPGT to analyses the availability of a biscuit manufacturing facility with three units that experience frequent failure and repair rates. Drawing tables and graphs, followed by comments, illustrate the effect of unit failure or repair rates on system performance characteristics while maintaining unit failure or repair rates constant while modifying other unit performance factors.

Keywords: Biscuit Plant, RPGT, Availability, Optimization, MTSF, Sensitivity.

1. INTRODUCTION
Modern engineering bakery operations face competition and a challenge in ensuring optimal production costs and a short design cycle time to achieve performance and durability. Given that modern items might be simple or complicated, bakery factories should be well-designed with the best system parameters and availability. The sensitivity analysis of a repairable biscuit manufacturing plant utilizing RPGT, based on Markov modeling for system parameter equation modeling, was covered in this work. The following sub-units make up a biscuit manufacturing facility: tilter framework and dough hopper in A; cutter and conveyor in B; metal detector and rotating system in M.

Using the RPGT-A general technique, Rajbala and Kumar [2021] presented reliability and availability analysis. The reliability technology theory has been examined by Kumar and Garg (2019). A bread-making system's behaviour analysis was researched by Kumar et al. in 2018. A sensitivity study of a cold standby architecture with priority for PM was examined by Kumar et al. in 2019. Rajbala, et al. [2019] conducted research on the EAEP manufacturing plant's system modeling and analysis. In the urea fertilizer sector, behavior analysis has been researched by Kumar et al. [2017]. An edible oil refinery plant's profit analysis was looked at by Kumar et al. in 2017. The behavioural study of a washing unit in a paper mill was researched by Kumar et al. in 2019. RPGT was used by Agrawal et al. [2021] to study the Water Treatment Reverse Osmosis Plant. In their study from 2018, Kumar et al. examined the sensitivity analysis of a 3:4:: excellent system plant. PSO was used by Kumari et al. [2021] to research the confined challenges. Garg and Kumar [2021] researched the theory and use of reliability technologies.

2. NOTATIONS
$y_{i:}$ Constant repair rates; $x_{i:}$ Constant failure rates

AOS: - Availability of the System; BPOS:- Busy Period of the Server

ENOIR: - Expected Number of Inspections by repairman

3. TRANSITION DIAGRAMS:

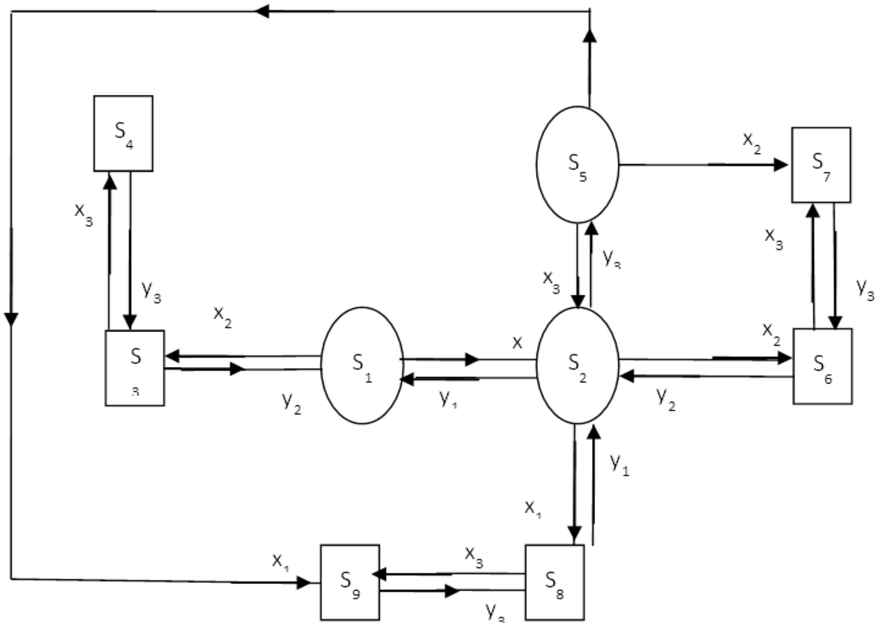

Fig. 1: Transition Diagram of Biscuits Plant in Sonipat

S_0 = A(A)B, S_1 = aAB, S_2 = A(A)b, S_3 = A(A)bM,

S_4 = aABM, S_5 = aAb, S_6 = aAbM, S_7 = aaB, S_8 = aaBM,

Evaluation of Path Probabilities: Applying RPGT and utilizing '1' as initial-state of the framework, we discovery transition probability aspects of all accessible states from first state 'ξ' = '1' .

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

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

$V_{1,3}$ = …..Continuous

Transition state probabilities from base state '2' are

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

$V_{2,2} = 1$

$V_{2,3}$ = …Continuous

4. MODELING SYSTEM PARAMETERS

MTSF (T_0): Regenerative un-failed states to which the framework can transit (initial state '2'), earlier incoming any fizzled state are: 'i' = 1, 2, 5 attractive 'ξ' = '1'

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

AOS (A_0): Regenerative states at which the framework is accessible are 'i' = 1, 2, 5 attractive 'ξ' = '1'

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

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

BPOS (B_0): Regenerative states where server is busy are $2 \leq j \leq 9$, attractive ξ = '1'

$B_0 = 1 - (\mu_j / D)$

ENOIR (V_0): Regenerative states where repair man does this job j = 2, 5 taking 'ξ' = '1', number of visit by repair man is given by

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

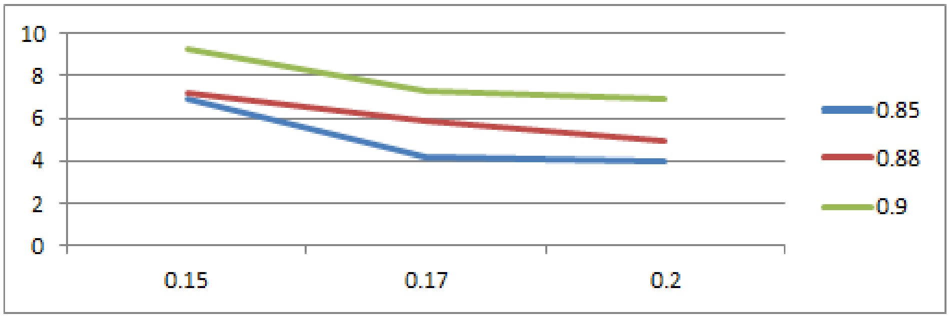

Figure 2: MTSF Graph

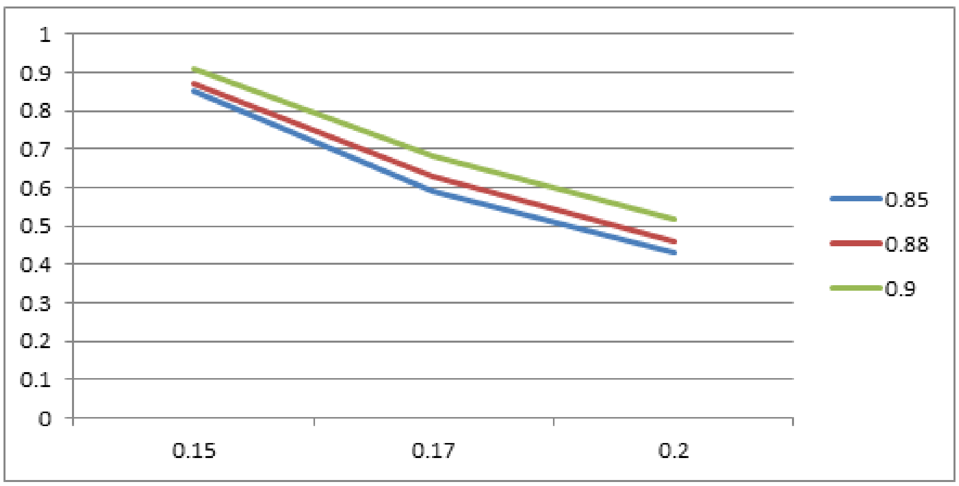

Figure 3: Availability Graph

5. CONCLUSION

The tables and graph above show that the results achieved with RPGT and RPT are identical. But with RPGT, one could reach the desired outcome quickly and easily without having to write any state equations, go through laborious processes, or simplify calculations. The organizations, manufacturers, and individuals involved in dependability manufacturing and working for performance are hoped to find the RPGT for the analysis of the framework to be highly accommodating.

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