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Profit Analysis of a Bread Making System Using RPGT

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Abstract: For the current investigation, one has selected the Bread Making System. Bread plants are only regarded as commercially viable when all five units are in good operating condition. When all five of the system's parts are in good operating order, the system operates at its peak efficiency. When three of the five units are operational, it operates at a reduced capacity. There are separate rates of continuous failure and repair for each of the four units. There is always one repairman available. With the aid of accurate scenarios, it is still necessary to determine how disappointment/repair rates affect the MTSF, accessibility, and server at a busy time.

Keywords: MTSF, Profit Analysis

1. Introduction

Present paper discusses profit analysis to break down transient conduct of repairable bakery producing plant utilizing RPGT, in considering Markov displaying for demonstrating system parameters conditions. The impact of repair and failure of units is inspected to acknowledge the ideal dimension of execution of framework parameters. For proficient and efficient tasks of process plants, each framework and sub-framework should keep running for a long duration of time with less cost under the given conditions. Thus, improvement in adequacy of a complex modern structure regarding various cost affected and reliability records has ended up being basic starting late. Assorted execution estimates used in process industry are indications to portray execution of a plant like system parameters. The greater part of parameters is associated to operational stage, while two or three these are useful to plan the units at a beginning time. It comprises of few sub-frameworks working in evolving nature, and each subsystem may furthermore be made from of various units related with different arrangements. While Kumar et al. (2017) examined the urea compost sector for system parameters, the primary goal of the paper by Kumar et al. (2019) focuses on the explored investigation of the washing element in the paper company consuming RPGT. Kumar et al.'s 2018 study concentrated on the examination of a bakery and an edible petroleum treatment facility. In Anchal et al.'s analysis of the SRGM classic using variance condition, dual types of deficiencies—simple and hard as for the timing of these for disengagement and expulsion following their recognition—have been reported. Researchers Kumar, A., Goel, and Garg (2018) looked into the behaviour of a system that makes bread in their discussion of the reliability technology theory and its applications. Using RPGT, Kumar, A., et al. (2019) looked at the profitability of a cold standby structure with priority for preventative maintenance that comprises of two identical units with server failure. The current paper consists of two units, one of which is accessible online and the other of which is kept in cold standby mode. The only two modes for both online and cold standby units are good and entirely failed. In 2017, Kumar, A., Garg, and Goel examined the mathematical modelling and profit analysis of an edible oil refinery facility. Kumar, A., Garg, D., and Goel (2019) investigated mathematical modelling and behavioural analysis in a paper mill washing unit. A work by Kumar, A., et al. (2018) looked at the profitability analysis of a 3:4:: outstanding system plant. The system modelling and analysis of the EAEP manufacturing plant was the subject of research by Rajbala et al. in 2019. Behavioural analysis has been studied in the urea fertiliser industry by Kumar, A., Goel, P., Garg, and Sahu (2017). The RPGT technique was used to carry out the mathematical formulation. Different formulas for system parameters are produced by assuming that failure/repair rates are independent and constant. Tables and figures are used to discuss system sensitivity and behavior analysis.

A bread making framework is a complex type of reparable engineering framework model involving a high risk of economic loss in case of any interruption in its operation. The framework consists of a number of several subsystems that are connected in series. The failure rates of subsystems are assumed to be exponential while repair rates are taken to be constant. The working of these subsystems is explained as follows:-

- **Mixer (A):** This is utilized for mixing the fixings to form mixture. An active excess of mixer is additionally considered in the framework to make it more reliable.

- **DRR (B) (Divider, Roller, and Rounder):** This is utilized to partition dough pieces, and then they go through the rounder for the adjusting of batter pieces. After this, the dough is leveled by the adjustable stainless steel molders of the mixture roller.
- **Proofer (C):** This is utilized for twisting dough to take a jump to accomplish the level of the form size.
- **Oven (D):** This unit is utilized for heating the bread coming from proofer at the ideal temperature.
- **Tunnels (E):** After baking, the form is placed into the hot tunnel where the hot loaves accomplish the necessary temperature, and then it is transferred into cold tunnel for cooling.

A fuzzy concept is utilized to decide the disappointment/working condition of a unit. Taking repair rates general and constant, failure rates exponential (constant), a transition diagram of framework is analyzed to find Secondary, Primary, and Tertiary circuits. The issues are unraveled using RPGT to decide framework parameters. System behavior and cost benefit is discussed with the assistance of figures.

2. Assumptions and Notations

- Failures/repairs are statistically independent.
- Assuming that DRR is never failed.

β_0 : Mixer

β_1 : Proofer

β_2 : Oven

β_3 : Tunnels

α_i $(0 \le i \le 4)$: Constant repair rate of units.

β_i $(0 \le i \le 4)$: Constant failure rate of units.

B/b : Unit 'B' in full capacity working/failed state. Similarly, for other units bar over a unit notation shows unit is under repair.

2.1 Transition Diagram: Considering the above notations and assumptions transition diagram is presented in Fig. 1.

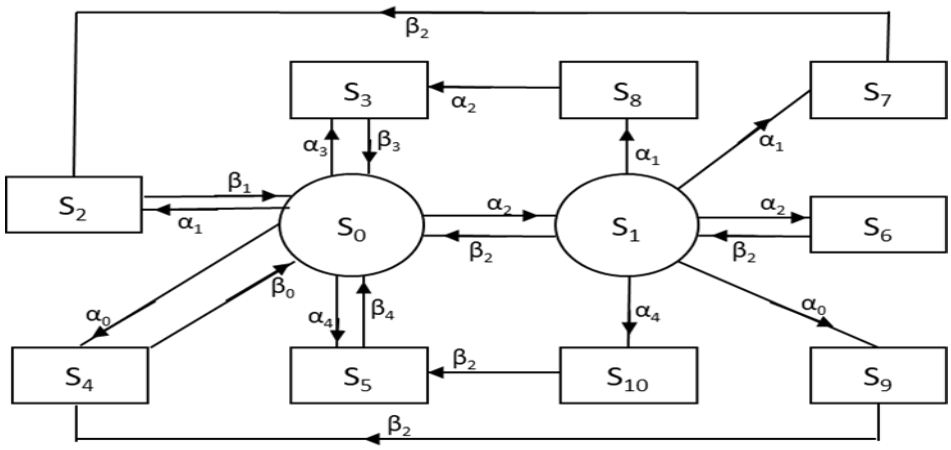

Fig. 1 Transition Diagram of System

S_0 = ABCDE, $S_1 = AB\bar{C}DE$, $S_2 = A\bar{B}CDE$,

$S_3 = AB\overline{CD}E$ $S_4 = \bar{A}BCDE$, $S_5 = ABCD\bar{E}$,

$S_6 = AB\underline{c}DE$, $S_7 = A\underline{b}CDE$ $S_8 = A\underline{b}CDE$,

$S_9 = \underline{a}BCDE$, $S_{10} = ABCD\underline{e}$

3. Transition Probabilities and Mean Sojourn Time.

Transition Probabilities: p_f: Transition probabilities factor of transition. $p_{i,j}$: $p_{i,j} = q_{i,j}(t)$^* (0); where * indicates Laplace transformation. $p_{i,j.k}$: $p_{i,j.k} = q_{i,j.k}(t)$^* (0).

Table 1: Transition Probabilities

$q_{i,j}(t)$	$P_{ij} = q^*_{i,j}(0)$
$q_{0,1}(t) = \alpha_2 e^{-(\alpha_2+\alpha_3+\alpha_1+\alpha_0+\alpha_4)t}$	$p_{0,1} = \alpha_2/(\alpha_4+\alpha_0+\alpha_1+\alpha_4+\alpha_2)$
$q_{0,2}(t) = \alpha_1 e^{-(\alpha_2+\alpha_3+\alpha_1+\alpha_0+\alpha_4)t}$	$p_{0,2} = \alpha_1/(\alpha_2+\alpha_0+\alpha_1+\alpha_4+\alpha_3)$
$q_{0,3}(t) = \alpha_3 e^{-(\alpha_2+\alpha_3+\alpha_1+\alpha_0+\alpha_4)t}$	$p_{0,3} = \alpha_3/(\alpha_4+\alpha_3+\alpha_1+\alpha_0+\alpha_2)$
$q_{0,4}(t) = \alpha_0 e^{-(\alpha_2+\alpha_3+\alpha_1+\alpha_4)t}$	$p_{0,4} = \alpha_0/(\alpha_1+\alpha_3+\alpha_2+\alpha_0+\alpha_4)$
$q_{0,5}(t) = \alpha_4 e^{-(\alpha_2+\alpha_3+\alpha_1+\alpha_0+\alpha_4)t}$	$p_{0,5} = \alpha_4/(\alpha_2+\alpha_3+\alpha_1+\alpha_0+\alpha_4)$
$q_{1,0}(t) = \beta_2 e^{-(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)t}$	$p_{1,0} = \beta_2/(\beta_2+\alpha_1+\alpha_4+\alpha_2+\alpha_0+\alpha_1)$
$q_{1,6}(t) = \alpha_2 e^{-(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)t}$	$p_{1,6} = \alpha_2/(\beta_2+\alpha_1+\alpha_4+\alpha_2+\alpha_0+\alpha_1)$
$q_{1,7}(t) = \alpha_1 e^{-(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)t}$	$p_{1,7} = \alpha_1/(\beta_2+\alpha_1+\alpha_1+\alpha_4+\alpha_0+\alpha_2)$
$q_{1,8}(t) = \alpha_1 e^{-(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)t}$	$p_{1,8} = \alpha_1/(\beta_2+\alpha_1+\alpha_4+\alpha_2+\alpha_0+\alpha_1)$
$q_{1,9}(t) = \alpha_0 e^{-(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)t}$	$p_{1,9} = \alpha_0/(\beta_2+\alpha_1+\alpha_4+\alpha_2+\alpha_0+\alpha_1)$
$q_{1,10}(t) = \alpha_4 e^{-(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)t}$	$p_{1,10} = \alpha_4/(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)$

$q_{2,0}(t) = \beta_1 e^{-\beta_1 t}$	$p_{2,0} = (\beta_1/\beta_1) = 1$
$q_{3,0}(t) = \beta_3 e^{-\beta_3 t}$	$p_{3,0} = 1$
$q_{4,0}(t) = \alpha_0 e^{-\alpha_0 t}$	$p_{4,0} = 1$
$q_{5,0}(t) = \beta_4 e^{-\beta_4 t}$	$p_{5,0} = 1$
$q_{6,1}(t) = \beta_2 e^{-\beta_2 t}$	$p_{6,1} = 1$
$q_{7,2}(t) = \beta_2 e^{-\beta_2 t}$	$p_{7,2} = 1$
$q_{8,3}(t) = \alpha_2 e^{-\alpha_2 t}$	$p_{8,3} = 1$
$q_{9,4}(t) = \beta_2 e^{-\beta_2 t}$	$p_{9,4} = 1$
$q_{10,5}(t) = \beta_2 e^{-\beta_2 t}$	$p_{10,5} = 1$

Mean Sojourn Time: At various verses these are given in table 2

Table 2: Mean Sojourn Time

$R_i(t)$	$\mu_i = R_i^*(0)$
$R_0(t) = e^{-(\alpha_2+\alpha_3+\alpha_1+\alpha_0+\alpha_4)t}$	$\mu_0 = 1/(\alpha_2+\alpha_3+\alpha_1+\alpha_0+\alpha_4)$
$R_1(t) = e^{-(\beta_2+\alpha_1+\alpha_1+\alpha_2+\alpha_0+\alpha_4)t}$	$\mu_1 = 1/(\beta_2+2\alpha_1+\alpha_2+\alpha_0+\alpha_4)$
$R_2(t) = e^{-\beta_1 t}$	$\mu_2 = 1/\beta_1$
$R_3(t) = e^{-\beta_3 t}$	$\mu_3 = 1/\beta_3$
$R_4(t) = e^{-\alpha_0 t}$	$\mu_4 = 1/\alpha_0$
$R_5(t) = e^{-\beta_4 t}$	$\mu_5 = 1/\beta_4$
$R_6(t) = e^{-\beta_2 t}$	$\mu_6 = 1/\beta_2$
$R_7(t) = e^{-\beta_2 t}$	$\mu_7 = 1/\beta_2$
$R_8(t) = e^{-\alpha_2 t}$	$\mu_8 = 1/\alpha_2$
$R_9(t) = e^{-\beta_2 t}$	$\mu_9 = 1/\beta_2$
$R_{10}(t) = e^{-\beta_2 t}$	$\mu_{10} = 1/\beta_2$

4. Path probabilities

The various transition probabilities/likelihood factors of reachable states from base state are below.

$V_{0,0} = 1$

$V_{0,1} = [(0, 1)/ \{1- (1, 6, 1)\}] = [p_{0,1}/ (1-p_{1,6}\, p_{6,1})]$

$= [\alpha_2 (\beta_2 + 2\alpha_1 + \alpha_4 + \alpha_0 + \alpha_2)]/ [(\alpha_2 + \alpha_3 + \alpha_0 + \alpha_1 + \alpha_4) (\beta_2 + 2\alpha_1 + \alpha_0 + \alpha_4)]$

$V_{0,2}$ = ….Continuous

MTSF (T_0): The regenerative un-fizzled states in which framework can transit from initial state '0', Preceding any fizzled state are: 'i' = 0, 1 taking 'ξ' = '0'.

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

$T_0 = (V_{0,i}\, \mu_i)/ (1- p_{0,1}\, p_{1,0})$; $(0 \leq i \leq 1)$

Availability of the System (A_0): The states in which framework is accessible are 'j' = 0, 1 and regenerative states are 'i' = $0 \leq i \leq 10$ taking 'ξ' = '0' the all-out portion of time for which framework is accessible is given by

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

$$A_0 = \left[\sum_j V_{\xi,j}\,, f_j\,, \mu_j\right] \div \left[\sum_i V_{\xi,i}\,, f_j\,, \mu_i^1\right]$$

$= (V_{0,I}\, \mu_i)/ D$; $(0 \leq i \leq 1)$

Where $D = (V_{0,j}\, \mu_j)$; $(0 \leq j \leq 10)$

Server of the Busy Period (B_0): The states in which server is busy are 'j' = $1 \leq j \leq 10$ and states are 'i' = $0 \leq i \leq 10$, from base state ξ = '0', total fraction of time for which server is busy

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

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

$B_0 = (V_{0,j}\, \mu_j)/ D$; $(1 \leq j \leq 10)$

Expected Fractional Number of Inspections by repairman (V_0): The states where repairmen do this job 'j' = 1, states are 'i' = $0 \leq i \leq 10$, Taking 'ξ' = 0, number of visits by repairman is given by

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

$$V_0 = \left[\sum_j V_{\xi,j}\right] \div \left[\sum_i V_{\xi,i}\,, \mu_i^1\right] = (V_{0,1}\, \mu_1)/ D$$

5. **Profit Function:** The system can be done by utilized profit function

$P_0 = D_1A_0 – (D_2B_0 + D_3V_0) = D_1A_0 – D_2B_0 - D_3V_0$

Where: $D_1 = 2000$; $D_2 = 50$; $D_3 = 100$

Table 3: Profit Function (P_0)

β \ α	0.5	0.6	0.7	0.8
0.1	46.03	31.31	19.91	12.26
0.2	125.13	100.11	81.72	67.20
0.3	191.47	159.71	135.32	116.02
0.4	247.93	211.27	182.66	159.76

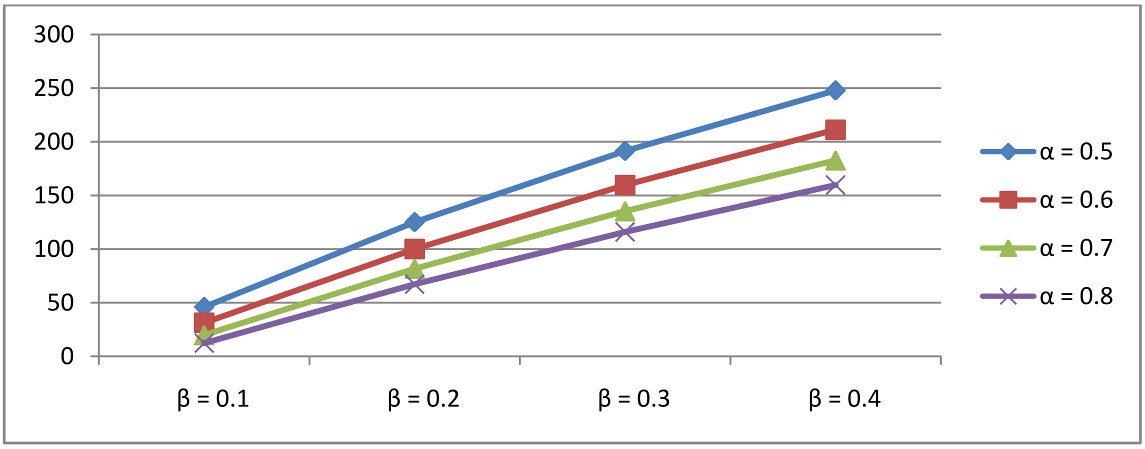

Fig. 2: Profit Function

6. Conclusion:

From the fig. 2 and table 3, it is seen that profit increase with the expansion in repair rates for example profit is directly proportional to the repair rates of units and profit diminishes with the expansion in the estimations of failure rates of units; henceforth profit function is conversely proportional to the failure rates.

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