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Cost benefit analysis of a stochastic model on automated teller machines considering hardware, software, and networking issues

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Abstract

This study proposes a stochastic model for Automated Teller Machines (ATM) that includes a number of different software and hardware elements. During operation, an Automated Teller Machine (ATM) can operate in three different modes: active, deterioration, and failure. There could be a variety of major and minor issues in the hardware and software components. A minor fault causes a partial failure, whereas a major fault and networking problems cause the system to fail completely. The bank staff or security people undertake the first level basic maintenance on the ATM whenever it enters a state of deterioration. After determining if the issue is with a software or hardware component, security staff repairs the appropriate part. ATM technicians or engineers are performing second level maintenance if the issue continues or if the ATM enters a failed state. Before recovering the pertinent component, the specialists first check to see if there is a hardware or software component malfunction or a network or connectivity problem. A variety of system performance metrics are derived through the use of Markov processes and the regenerative point technique. The system's performance and profitability are analyzed based on these metrics. Graphical studies are also used to draw a variety of conclusions on the system's reliability, performance, and profitability.

Keywords: Automated Teller Machines (ATM), Networking Issue, Mean Time to System Failure (MTSF), Markov Process, Regenerative Point Technique, Profit

1. Introduction

ATMs are vital for providing convenient, round-the-clock banking services, enabling transactions like cash withdrawals, deposits, fund transfers, and balance inquiries without bank staff. Advances in technology have expanded their functions to include bill payments, fixed deposits, and loan applications. In today's competitive market, banks must ensure high ATM performance and reliability, as system failures can disrupt services, harm reputation, and lead to financial losses. Minimizing downtime to enhance system dependability is a key priority for both banks and users. ATMs can encounter both minor and major faults. Minor issues are addressed through First Level Maintenance (FLM), which involves basic, non-technical tasks like cash refilling, simple hardware checks, and routine security inspections typically handled by bank staff or security personnel. Major faults require Second Level Maintenance (SLM), performed by trained technicians to resolve complex hardware and software problems. SLM tasks include repairing or replacing components like card readers, cash dispensers, screens, and printers, as well as updating software, fixing network issues, and enhancing security features. ATM faults generally fall into three categories: hardware (e.g., jammed dispensers, card reader or screen failures), software (e.g., system freezes, processing errors), and network-related (e.g., server outages, connectivity failures, authentication issues).

Many researchers in the field of reliability modeling including Goyal *et al* (2010) ^[5], Kumar and Batra (2012) ^[8], and many more analyzed a large number of systems considering various concepts such as different failure modes, repairs, replacements, inspections, different operational stages etc. Kumar and Kumar (2012) ^[10] introduces a hardware-software system that can encounter failures in the hardware components, software modules, and their mutual interactions. Bhatia and Kumar (2013) ^[11] present a stochastic model for a single-unit

centrifuge system using real data from the Thermal Power Plant in Panipat, Haryana, categorizing faults as minor, major, or negligible. Kumar and Kapoor (2013)^[9] introduced a stochastic model for a Base Transceiver System (BTS) comprising multiple hardware and software components. The system is designed to operate in four distinct modes: normal, congested, down, and failed. Two stochastic models are comparatively analyzed in the context of a base transceiver system by authors Kapoor and Kumar (2014)^[5]. Yousaf *et al* (2014)^[15] proposes a fuzzy multi-criteria decision-making (MCDM) model using Fuzzy TOPSIS to evaluate the ATM performance, focusing on cost-benefit factors. Barak and Malik (2014)^[3] conduct a stochastic analysis of a two-unit parallel system exposed to random shocks. Kapoor and Kumar (2018)^[14] present a stochastic model for a base transceiver station accounting for hardware and software faults, traffic congestion, common cause failures, and hardware-induced software failures. Kumari and Kumar (2021)^[12] propose a stochastic model for a three-unit system operating over three mission phases with varying configurations: parallel, series, and parallel. Each unit can be in a good, degraded, or failed state. Repairs follow a Last-Come-First-Served (LCFS) policy, prioritizing the most recently failed unit.

Apoorva and Taneja (2022)^[1] analyze a Markovian reliability model for a self-protecting system that detects security risks and responds by entering a protective mode. Apoorva and Taneja (2023)^[2] introduces a stochastic model for a single-unit self-adaptive system, which operates in different modes during its adaptive phase: normal, low-efficiency, and high-efficiency. Malik and Yadav (2024)^[13] developed a stochastic model by considering human (operator) redundancy in a cold standby configuration having one unit represents the electronic system, comprising both hardware and software components, while the other unit represents the human operator. Bhardwaj and Kumar (2025)^[4] analyze a stochastic model of the human cardiovascular system, taking into account various scenarios of heart damage, failure, and recovery. Kapoor (2018)^[14] analyzed the performance of stochastic model on Automated Teller Machine considering major and minor faults, however none of the researcher has carried out the analysis of ATM considering hardware/software faults and networking issues.

To bridge this gap, this study considers a stochastic model for Automated Teller Machines (ATM) that includes a number of different software and hardware elements. During operation, an Automated Teller Machine (ATM) can operate in three different modes: active, deterioration, and failure. There could be a variety of major and minor issues in the hardware and software components. A minor fault causes a partial failure, whereas a major fault and networking problems cause the system to fail completely. The bank staff or security people undertake the first level basic maintenance on the ATM whenever it enters a state of deterioration. After determining if the issue is with a software or hardware component, security staff repairs the appropriate part. ATM technicians or engineers are performing second level maintenance if the issue continues or if the ATM enters a failed state. Before recovering the pertinent component, the specialists first check to see if there is a hardware or software component malfunction or a network or connectivity problem. A variety of system performance metrics are derived through the use of Markov processes and the regenerative point technique. The system's profitability is analyzed based on these metrics. Graphical studies are also used to draw a variety of conclusions on the system's reliability, performance, and profitability.

2. Abbreviation and Notations

MTSF Mean Time to System Failure

MST Mean Sojourn Time

O Operative state

λ_1 Major faults occurrence rate

λ_2 Minor faults occurrence rate

$p_1/p_2/p_3$ Probability of major faults due to Hardware component/Software component/networking issues

q_1/q_2 Probability of minor faults due to Hardware component/Software component

$q_{ij}(t)/Q_{ij}(t)$ Probability of transitions from state 'i' to state 'j'

$g_{h1}(t)/G_{h1}(t)$ P.d.f./c.d.f of repair time of major faults due to hardware component

$g_{s1}(t)/G_{s1}(t)$ P.d.f./c.d.f of repair time of major faults due to software component

$g_{h2}(t)/G_{h2}(t)$ P.d.f./c.d.f of repair time of minor faults due to hardware component

$g_{s2}(t)/G_{s2}(t)$ P.d.f./c.d.f of repair time of minor faults due to software component

$g_{N1}/G_{N1}(t)$ P.d.f./c.d.f of repair time of major faults due to networking issues

$i_1(t)/I_1(t)$ P.d.f./C.d.f of inspection time of major fault

$i_2(t)/I_2(t)$ P.d.f./C.d.f. of inspection time of minor fault

$\otimes/\odot$ Standard notation for Laplace-Stieltjes convolution/Laplace convolution

*/** Symbol for Laplace Transform (LT)/Laplace Stieltjes Transform

3. Assumptions and State Description

The following assumptions are considered to describe the system

1. Minor or major faults may occur in either hardware or software components.
2. Network-related issues in the system result in a failure state.
3. Minor Faults are promptly addressed by the FLM team and Major faults are promptly addressed by SLM team.
4. Faults occur at a constant rate, while the repair and inspection times follow arbitrary distributions.
5. Following each repair, the system is restored to its original condition.
6. System switching is flawless and occurs instantaneously.
7. All random variables are statistically independent of one another.
8. The technicians are available immediately at the site to handle all types of faults.

The description of all states is given in the Table 1

Table 1: Descriptions for each state defined in the system model

States	Symbols	Description
State 0	O	System is in Active state
State 1	F _i	The system has been failed and is currently under inspection.
State 2	O _i	System is in deteriorated state and is currently under inspection
State 3	F _h	System failure caused by a hardware component.
State 4	F _s	System failure caused by a software component.
State 5	F _N	System failure caused by a networking issue.
State 6	O _h	System is in a deteriorated state as a result of a hardware fault.
State 7	O _s	system is in deteriorated state due to software fault

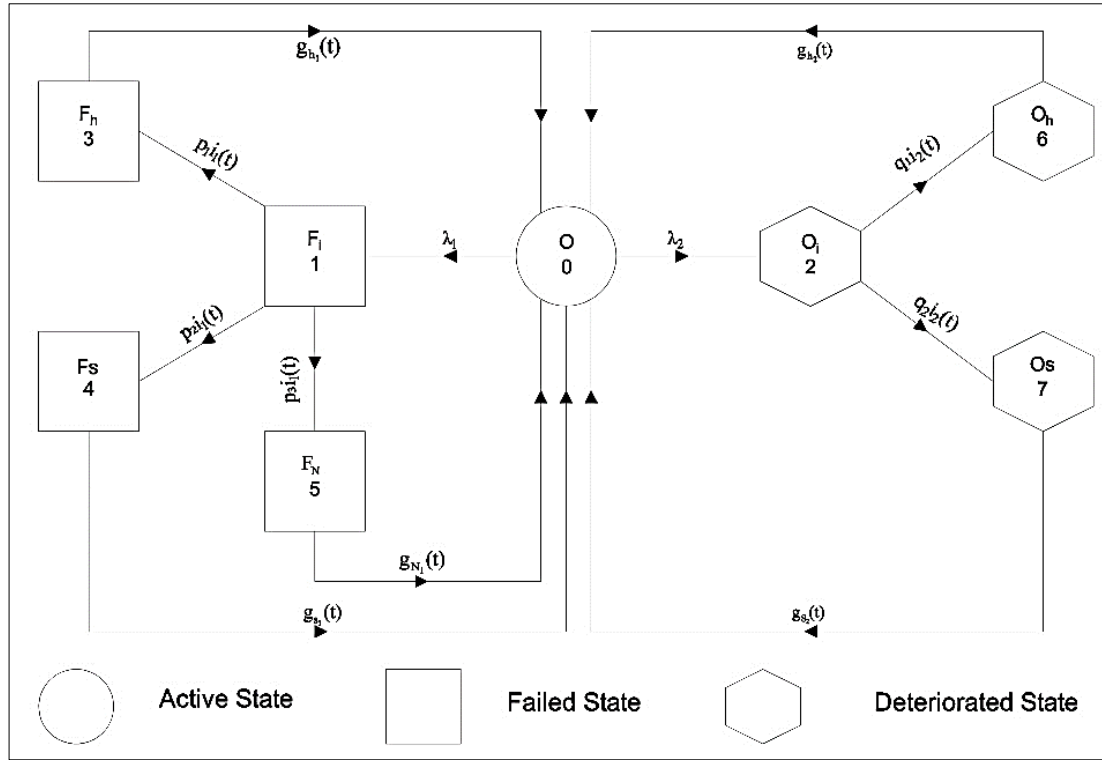


Fig 1: State Transition Diagram

4. Reliability Measures

4.1 Transition Probabilities

A state transition diagram is presented in Fig. 1, illustrating the various transitions between system states. The moments at which the system enters states 0, 1, 2, 3, 4, 5, 6, and 7 are considered regenerative points—meaning all these states are regenerative in nature.

The transition probabilities are

$$q_{01} = \lambda_1 e^{-(\lambda_1 + \lambda_2)t} \quad q_{02} = \lambda_2 e^{-(\lambda_1 + \lambda_2)t} \quad q_{13} = p_{11}(t) \quad q_{14} = p_{21}(t) \quad q_{15} = p_{31}(t) \quad q_{26} = q_{12}(t) \quad q_{27} = q_{22}(t) \quad q_{30} = g_{h1}(t) \\ q_{40} = g_{s1}(t) \quad q_{50} = g_{N1}(t) \quad q_{60} = g_{h2}(t) \quad q_{70} = g_{s2}(t)$$

The non-zero elements $p_{ij} = \lim_{s \rightarrow 0} q_{ij}^*(s)$

$$p_{01} = \frac{\lambda_1}{\lambda_1 + \lambda_2}$$

$$p_{02} = \frac{\lambda_2}{\lambda_1 + \lambda_2}$$

$$p_{13} = p_{11}^*(0) \quad p_{14} = p_{21}^*(0) \quad p_{15} = p_{31}^*(0)$$

$$p_{26} = q_{12}^*(0) \quad p_{27} = q_{22}^*(0) \quad p_{30} = g_{h1}^*(0)$$

$$p_{40} = g_{s1}^*(0) \quad p_{50} = g_{N1}^*(0) \quad p_{60} = g_{h2}^*(0) \quad p_{70} = g_{s2}^*(0)$$

By these transition probabilities, it can be verified that

$$p_{01} + p_{02} = p_{13} + p_{14} + p_{15} = p_{26} + p_{27} = 1$$

$$p_{30} = p_{40} = p_{50} = p_{60} = p_{70} = 1$$

4.2 Mean Sojourn Time

The mean sojourn time (μ_i) in the regenerative state i is defined as the time of stay in that state before transition to any other state. If T denotes the sojourn time in regenerative state i , then

$$\mu_0 = \frac{1}{\lambda_1 + \lambda_2} \quad \mu_1 = -i_1^{**}(0) \quad \mu_2 = -i_2^{**}(0) \quad \mu_3 = -g_{h_1}^{**}(0) \quad \mu_4 = -g_{s_1}^{**}(0) \quad \mu_5 = -g_{N_1}^{**}(0) \quad \mu_6 = -g_{h_2}^{**}(0) \quad \mu_7 = -g_{s_2}^{**}(0)$$

The unconditional mean time taken by the system to transit for any regenerative state j , when it is counted from epoch of entrance into that state i , is mathematically stated as

$$m_{ij} = \int t q_{ij}(t) DE$$

Thus,

$$m_{01} + m_{02} = \mu_0 \quad m_{13} + m_{14} + m_{15} = \mu_1 \quad m_{26} + m_{27} = \mu_2$$

$$m_{30} = \mu_3 \quad m_{40} = \mu_4 \quad m_{50} = \mu_5 \quad m_{60} = \mu_6 \quad m_{70} = \mu_7$$

4.3 Mean Time to System Failure (MTSF)

To evaluate the Mean Time to System Failure (MTSF), the failed states are treated as absorbing states. Using probabilistic reasoning, we derive the following recursive relations for $\chi_i(t)$, the cumulative distribution function (c.d.f.) of the first passage time from regenerative state i to a failed state.:

$$\chi_0(t) = Q_{01}(t) \oplus \chi_2(t)$$

$$\chi_2(t) = Q_{26}(t) \oplus \chi_6(t) + Q_{27}(t) \oplus \chi_7(t)$$

$$\chi_6(t) = Q_{60}(t) \oplus \chi_0(t)$$

$$\chi_7(t) = Q_{70}(t) \oplus \chi_0(t)$$

Using Laplace stieljes transforms, the above recursive relations are solved in terms of $\chi_0^{**}(s)$, The Mean time to system failure (MTSF) when the system starts from the state 0, is

$$T_0 = \lim_{s \rightarrow 0} \frac{1 - \chi_0^{**}(s)}{s} = \frac{N}{D}$$

where,

$$N = \mu_0 + \mu_2 p_{02} + p_{02} (p_{26} \mu_6 + p_{27} \mu_7)$$

$$D = p_{01}$$

4.4 Estimated Active Time of the System

Based on the principles of regenerative process theory, the estimated active time $AC_i(t)$ which represents the probability that the system is active at time t , given it entered regenerative state i at $t=0$ satisfies the following set of recursive relations:

$$AC_0(t) = M_0(t) + q_{01} \odot AC_1(t) + q_{02} \odot AC_2(t)$$

$$AC_1(t) = q_{13} \odot AC_3(t) + q_{14} \odot AC_4(t) + q_{15} \odot AC_5(t)$$

$$AC_2(t) = q_{26} \odot AC_6(t) + q_{27} \odot AC_7(t)$$

$$AC_3(t) = q_{30} \odot AC_0(t)$$

$$AC_4(t) = q_{40} \odot AC_0(t)$$

$$AC_5(t) = q_{50} \odot AC_0(t)$$

$$AC_6(t) = q_{60} \odot AC_0(t)$$

$$AC_7(t) = q_{70} \odot AC_0(t)$$

Where

$$N_1 = \mu_0$$

$$D_1 = \mu_0 + p_{01} \mu_1 + p_{02} \mu_2 + p_{01} p_{13} \mu_3 + p_{01} p_{14} \mu_4 + p_{01} p_{15} \mu_5 + p_{02} p_{26} \mu_6 + p_{02} p_{27} \mu_7$$

4.5 Estimated Deteriorating Time of the System

According to the theory of regenerative processes, the estimated deteriorating time of the system $DE_i(t)$ defined as the probability that the system is in a failed state at time t , given that it entered regenerative state i at $t=0$ is governed by the following recursive relations:

$$DE_0(t) = q_{01}(t) \odot DE_1(t) + q_{02}(t) \odot DE_2(t)$$

$$DE_1(t) = q_{13}(t) \odot DE_3(t) + q_{14}(t) \odot DE_4(t) + q_{15}(t) \odot DE_5(t)$$

$$DE_2(t) = M_2(t) + q_{26}(t) \odot DE_6(t) + q_{27}(t) \odot DE_7(t)$$

$$DE_3(t) = q_{30}(t) \odot DE_0(t)$$

$$DE_4(t) = q_{40}(t) \odot DE_0(t)$$

$$DE_5(t) = q_{50}(t) \odot DE_0(t)$$

$$DE_6(t) = M_6(t) + q_{60}(t) \odot DE_0(t)$$

$$DE_7(t) = M_7(t) + q_{70}(t) \odot DE_0(t)$$

Where

$$M_2(t) = \bar{I}_2(t) \quad M_6(t) = \bar{G}_{h_2}(t) \quad M_7(t) = \bar{G}_{s_2}(t)$$

Using Laplace transforms, the above recursive relations are solved in terms of $DE_0^*(s)$,
The steady state availability of the system is given by

$$DE_0 = \lim_{s \rightarrow 0} (s DE_0^*(s)) = \frac{N_2}{D_1}$$

Where

- $N_2 = p_{02}\mu_2 + p_{02}p_{26}\mu_6 + p_{02}p_{27}\mu_7$
- D_1 =already defined.

4.6 Estimated Busy Period of Technician (Inspection Time Only)

Applying the principles of regenerative process theory, the following recursive relations have been derived

$$BI_0(t) = q_{01}(t) \odot BI_1(t) + q_{02}(t) \odot BI_2(t)$$

$$BI_1(t) = W_1(t) + q_{13}(t) \odot BI_3(t) + q_{14}(t) \odot BI_4(t) + q_{15}(t) \odot BI_5(t)$$

$$BI_2(t) = W_2(t) + q_{26}(t) \odot BI_6(t) + q_{27}(t) \odot BI_7(t)$$

$$BI_3(t) = q_{30}(t) \odot BI_0(t)$$

$$BI_4(t) = q_{40}(t) \odot BI_0(t)$$

$$BI_5(t) = q_{50}(t) \odot BI_0(t)$$

$$BI_6(t) = q_{60}(t) \odot BI_0(t)$$

$$BI_7(t) = q_{70}(t) \odot BI_0(t)$$

Where

$$W_1(t) = \bar{I}_1(t) \quad W_2(t) = \bar{I}_2(t)$$

Using Laplace transforms, the above recursive relations are solved in terms of $BI_0^*(s)$, In steady-state, the total fraction of time for which the system is under inspection is given by

$$BI_0 = \lim_{s \rightarrow 0} (s BI_0^*(s)) = \frac{N_3}{D_1}$$

Where

$$N_3 = p_{01}\mu_1 + p_{02}\mu_2$$

D_1 =already defined.

4.7 Estimated busy period of Technician (First level Maintenance only)

Applying the principles of regenerative process theory, the following recursive relations have been derived

$$BF_0(t) = q_{01}(t) \odot BF_1(t) + q_{02}(t) \odot BF_2(t)$$

$$BF_1(t) = q_{13}(t) \odot BF_3(t) + q_{14}(t) \odot BF_4(t) + q_{15}(t) \odot BF_5(t)$$

$$BF_2(t) = q_{26}(t) \odot BF_6(t) + q_{27}(t) \odot BF_7(t)$$

$$BF_3(t) = q_{30}(t) \odot BF_0(t)$$

$$BF_4(t) = q_{40}(t) \odot BF_0(t)$$

$$BF_5(t) = q_{50}(t) \odot BF_0(t)$$

$$BF_6(t) = W_6(t) + q_{60}(t) \odot BF_0(t)$$

$$BF_7(t) = W_7(t) + q_{70}(t) \odot BF_0(t)$$

Where

$$W_6(t) = \overline{G_{h_2}}(t) \quad W_7(t) = \overline{G_{s_2}}(t)$$

By applying Laplace transforms, the above recursive relations are solved. In the steady-state, the proportion of time the system remains under First level maintenance (FLM) is given by

$$BF_0 = \lim_{s \rightarrow 0} (sBF_0^*(s)) = \frac{N_4}{D_1}$$

Where

$$N_4 = p_{02}p_{26}\mu_6 + p_{02}p_{27}\mu_7$$

D_1 =already defined.

4.8 Estimated Busy period of Technician (Second level Maintenance only)

Applying the principles of regenerative process theory, the following recursive relations have been derived

$$BS_0(t) = q_{01}(t) \odot BS_1(t) + q_{02}(t) \odot BS_2(t)$$

$$BS_1(t) = q_{13}(t) \odot BS_3(t) + q_{14}(t) \odot BS_4(t) + q_{15}(t) \odot BS_5(t)$$

$$BS_2(t) = q_{26}(t) \odot BS_6(t) + q_{27}(t) \odot BS_7(t)$$

$$BS_3(t) = W_3(t) + q_{30}(t) \odot BS_0(t)$$

$$BS_4(t) = W_4(t) + q_{40}(t) \odot BS_0(t)$$

$$BS_5(t) = W_5(t) + q_{50}(t) \odot BS_0(t)$$

$$BS_6(t) = q_{60}(t) \odot BS_0(t)$$

$$BS_7(t) = q_{70}(t) \odot BS_0(t)$$

Where

$$W_3(t) = \overline{G_{h_1}}(t) \quad W_4(t) = \overline{G_{s_1}}(t) \quad W_5(t) = \overline{G_{N_1}}(t)$$

By applying Laplace transforms, the above recursive relations are solved. In the steady-state, the proportion of time the system remains under Second level maintenance (SLM) is given by

$$BS_0 = \lim_{s \rightarrow 0} (sBS_0^*(s)) = \frac{N_5}{D_1}$$

where

$$N_5 = p_{01}p_{13}\mu_3 + p_{01}p_{14}\mu_4 + p_{01}p_{15}\mu_5$$

D_1 =already defined.

4.9 Estimated Profit of the System

The estimated profit of the system is given by

$$P = C_0AC_0 - C_1DE_0 - C_2BI_0 - C_3BF_0 - C_4BS_0 - C_5$$

where

1. C_0 : Revenue earned per unit of system active time
2. C_1 : Cost incurred per unit of system deteriorating time
3. C_2 : Cost per unit time for inspections
4. C_3 : Cost per unit time for first-level maintenance only
5. C_4 : Cost per unit time for second-level maintenance only
6. C_5 : One-time installation cost of the system

5. Numerical Illustration

For graphical analysis following particular cases are considered:

$$g_{h_1}(t) = \beta_{h_1} e^{-\beta_{h_1}(t)}$$

$$g_{s_1}(t) = \beta_{s_1} e^{-\beta_{s_1}(t)}$$

$$g_{h_2}(t) = \beta_{h_2} e^{-\beta_{h_2}(t)}$$

$$g_{s_2}(t) = \beta_{s_2} e^{-\beta_{s_2}(t)}$$

$$g_{N_1}(t) = \beta_{N_1} e^{-\beta_{N_1}(t)}$$

$$i_1(t) = \alpha_1 e^{-\alpha_1(t)}$$

$$i_2(t) = \alpha_2 e^{-\alpha_2(t)}$$

Graphs for measures of system performances viz. MTSF and estimated active time are plotted for different values of major/minor faults occurrence rate, (λ_1, λ_2) , probabilities of major faults due to hardware component/software component/networking issues (p_1, p_2, p_3) , probabilities of minor faults due to hardware component/software component (q_1, q_2) , inspection rates (α_1, α_2) , repair rate of major/minor faults due to hardware/software component and networking issues $(\beta_{h_1}, \beta_{h_2}, \beta_{s_1}, \beta_{s_2}, \beta_{N_1})$. To determine the reliability measures, arbitrary values are used for the following parameters

$$\lambda_1 = 0.0021, \lambda_2 = 0.0042, \alpha_1 = 0.82, \alpha_2 = 0.84, \beta_{h_1} = 0.62, \beta_{s_1} = 0.64, \beta_{N_1} = 0.73, \beta_{h_2} = 0.76, \beta_{s_2} = 0.84$$

$$C_0 = 2000, C_1 = 1000, C_2 = 250, C_3 = 150, C_4 = 300, C_5 = 600$$

6. Graphical Interpretations

Figure 2 shows that the Mean Time to System Failure (MTSF) decreases with increase in major fault occurrence rate (λ_1) as well as probability of minor faults due to software component (q_2) . Similarly, Fig.3 reveals that expected Active time (AC_0) declines with a rise in minor fault occurrence rate (λ_2) and has lower value for higher value of probability of major fault due to hardware component (p_1) . Figures 4 and 5 show the impact of revenue per unit Active time (C_0) on system profit for varying values of major fault occurrence rate (λ_1) and minor fault occurrence rate (λ_2) , respectively. In both cases, for a fixed value of λ_1 or λ_2 , the system profit increases as (C_0) increases. Figure 6 presents the effect of the probability of major faults due to networking issues (p_3) on system profit for different values of the networking issues repair rate (β_{N_1}) . It clearly demonstrates that, for a fixed (β_{N_1}) , the profit decreases as the probability of major faults due to networking issues (p_3) increases

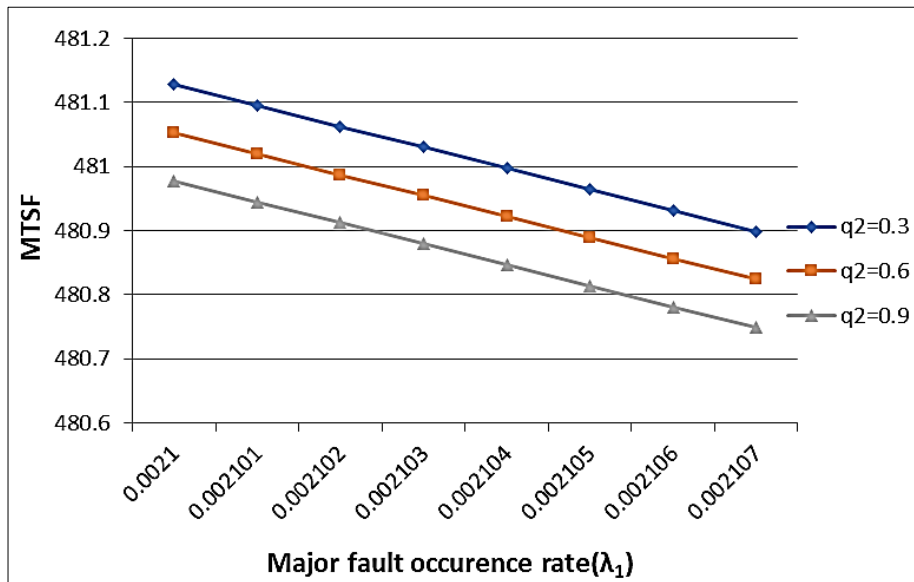


Fig 2: MTSF V/s Major faults occurrence rate for different values of Probability of minor faults due to software components

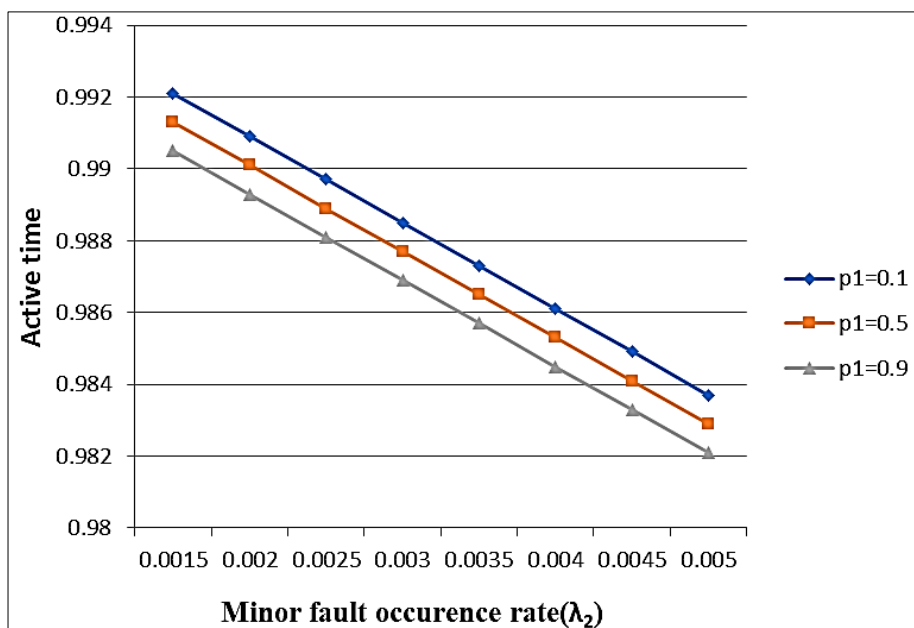


Fig 3: Expected Active time V/s Minor faults occurrence rate for Different Values of Probability of major Faults due to hardware component

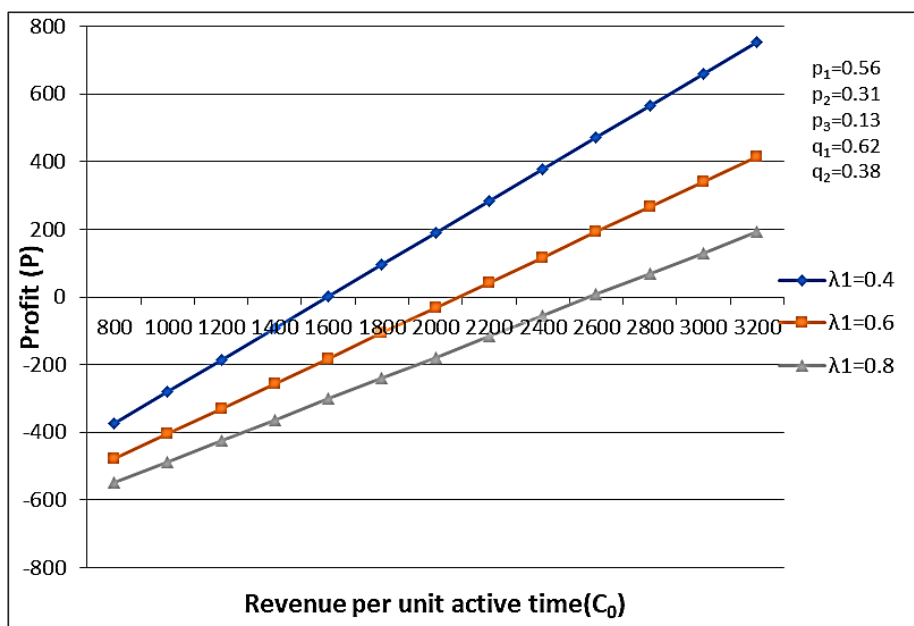


Fig 4: Profit V/s Revenue per Unit Active time for Different Values of Major faults occurrence rate

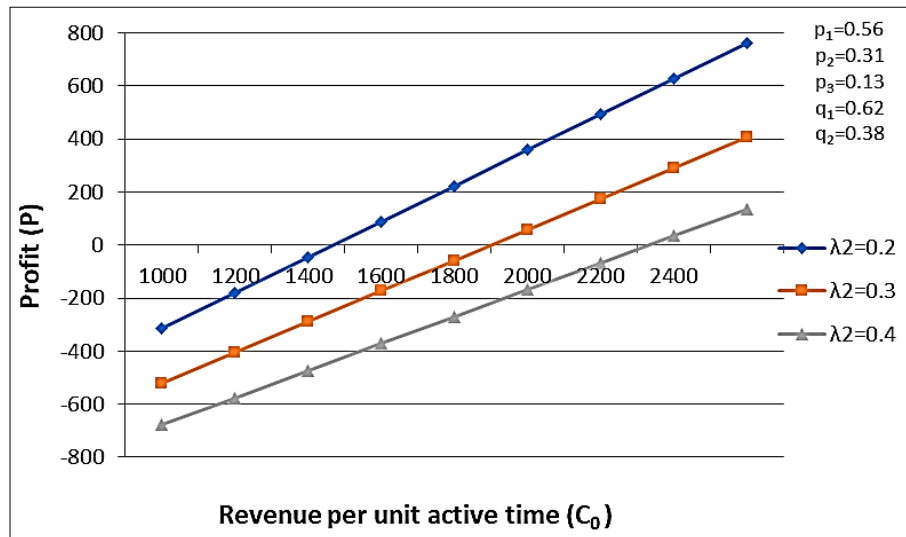


Fig 5: Profit V/s Revenue per unit Active time of the system for different values of Minor faults occurrence rate

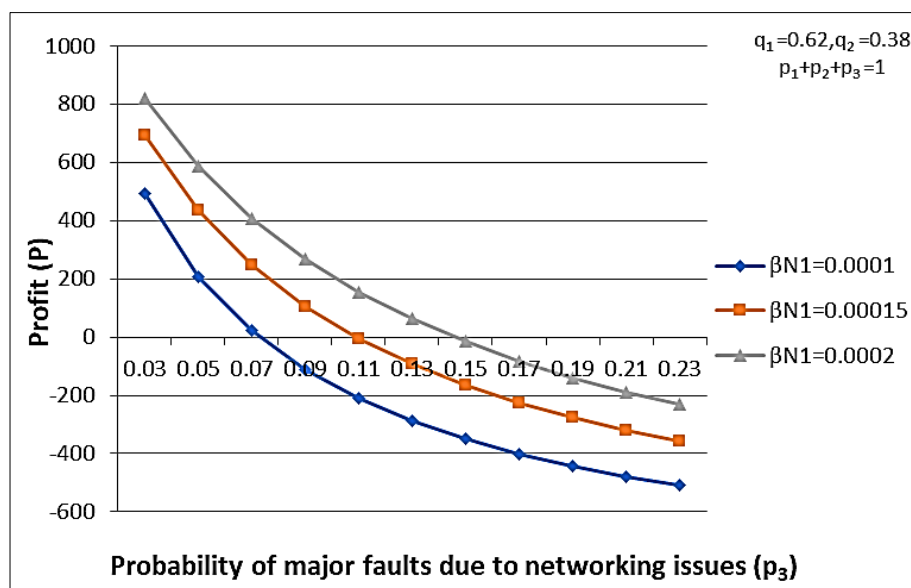


Fig 6: Profit V/s Probability of Occurrence of Major Faults due to Network issue for Different Values of Networking issues repair rate

Based on the graphical analysis, the following conclusions are derived in Table 2:

Table 2: Impact of various parameters on profitability

Figure	Parameter type	Parameter value	Profit Condition
Fig.4	Major Fault rate(λ_1)	$\lambda_1 = 0.4$	Profitability is achieved when $C_0 \geq$ Rs.1597.1862.
		$\lambda_1 = 0.6$	Profitability is achieved when $C_0 \geq$ Rs.2086.3250.
		$\lambda_1 = 0.8$	Profitability is achieved when $C_0 \geq$ Rs.2575.4669.
Fig. 5	Minor Fault rate(λ_2)	$\lambda_2 = 0.2$	Profitability is achieved when $C_0 \geq$ Rs.1468.5840.
		$\lambda_2 = 0.3$	Profitability is achieved when $C_0 \geq$ Rs.1900.3021.
		$\lambda_2 = 0.4$	Profitability is achieved when $C_0 \geq$ Rs.2332.0251.
Fig.6	Networking issue repair rate(β_{N_1})	$\beta_{N_1} = 0.0001$	Profitability is achieved when $p_3 \leq 0.0722$.
		$\beta_{N_1} = 0.00015$	Profitability is achieved when $p_3 \leq 0.2292$.
		$\beta_{N_1} = 0.0002$	Profitability is achieved when $p_3 \leq 0.1459$.

7. Conclusion

The graphs indicate that both the Mean time to system failure (MTSF) and the Expected Active time of the system decline as major and minor faults occurrence rate increase. Additionally, an increase in the probability of major and minor faults due to hardware and software components, further reduces the MTSF and Expected Active time. It is observed that the Profit rises with an increase in revenue per unit Active time, assuming fixed occurrence rate for both major and minor faults. Conversely, the profit declines as the probability of networking issues increases, given a constant repair rate for those issues.

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