International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 04, April 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

A SYSTEMATICAL STUDY OF RELIABILITY ON VARIOUS MODELS

Sunaina Goyal[1], Reetu Malhotra[2]

[1,2]*Department of applied sciences, Chitkara University, Punjab (India)*

ABSTRACT

The twenty first century is a century of technologies. Today, everyone has impact of these technologies, even industries, which are totally dependent on machines for their chores. Now, the great challenge for researchers/engineers is to produce highly reliable products at minimum cost. Thus, the fastest growing industries need to select highly reliable systems. The aim of present paper is to analyze the reliability and the behavior of mean time to system failure, availability, busy period and profit function with respect to systems parameters (failure rate, repair rate, service rate, etc). A tabular and graphical study also has been done to highlight the important results.

Keywords: Availability, Busy period, MTSF and Profit.

I. INTRODUCTION

In the present time, scenario of technological development with strong industrial revolution is changing the designing of systems i.e. complex systems and user needs reliable systems. Many attempts from the researchers, engineers and industries have been devoted to improve the performance and designing of existing machines. Moreover, great challenge for researchers and engineers is to produce high quality products at minimum cost. Thus, reliability and profit analysis plays a key role in defining quality of system.

Reliability systems can be classified as single unit system and multi unit systems. The single unit system is one which operates without any backup where the Multi unit systems are those in which one system is active or may have standby systems. Here standby systems further describes by three ways of standby configurations i.e. cold, warm, hot. Cold standby system is defined as when the failure rate of standby system is zero in initial state i.e. no chance of failure. For example power bank of mobile, car with stepney. Warm standby system is defined as when the failure rate of standby system is less then active system. For example, the stabilizer of refrigerator works partially. Hot standby system is defined as that system which have same failure rate of active system and standby system, such types of redundant systems are parallel systems. For example a truck having sixteen tiers because all tiers are working in parallel state.

Davis (1952) discussed failure data and goodness of fit tests for various competing failure distributions. Epstein and Sobel (1955) worked in the field of life testing with the assumption of exponential distribution. Gaver (1964) was the first who generalised repair time distribution and used supplementary variable technique to analyse his model. The concept of availability has been widely discussed in literature and the main contributors are Sandler (1963), Barlow and Proschan (1965). Srinivasan and Gopalan (1973) concentrated on regenerative point technique. Ramanarayanan and Usha (1979, 1980) works on n-unit warm and cold standby systems and used Erlang distribution to analyse system. Afterward Yasmashiro (1982) used supplementary

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

variable technique to analysis repairable system with n failure modes and k standby units. Gopalan and Naidu(1983) operate on 1-server, 2-unit system subject to non negligible inspection time for busy period but Rastogi and Kumar(1983) studied effect of intermitted in a 2-unit redundant system with standby failure. Goel and Sharma(1987) handles 2-unit standby system with 2 failure mode and slow switch and used regenerating point technique to analyse reliability and availability further Goel and Shrivastava(1990) works on 2-unit redundant system with provision for rest and correlated failure and repair.

Gupta and Bansal (1991) operate two unit cold priority standby system subject to degradation but Gupta and Goel(1991) runs two unit cold standby system with abnormal weather condition. Tuteja and Taneja(1992) works on 2-server, 2-unit, warm standby system and applied semi markov process and regenerative process to determine various reliability measures. Gupta *et al* (1993) handles two-unit priority standby system subject to degradation and random shocks. Rajamanickam and Chandrasekar(1997) used two unit systems with a dependent structure for failure and repair times and discussed Marashall Olkin distribution for failure and repair rate.

Further, Li *et al* (1998) work on repairable system with three units and two repair facilities and analysis model using supplementary variables method. Ke and Wang (2002) operate balking and reneging in repairable system with warm standby system. Said and Sherbeny (2005) work on 2-unit cold standby system with random change in unit and preventive maintenance. Wang *et al* (2007) studied repairable system with warm standbys and r unreliable service stations and analysis reliability and sensitivity of model. Wang and Chiu (2007) analysis cost benefits of systems with warm standby units and imperfect coverage. Nilsson and Bertling (2007) analysis cost and maintenance of wind power systems using condition monitoring systems. Parashar and Taneja (2007) operates hot standby system based on a master-slave and two repair facilities and used semi Markov processes and regenerative processes to analysis system.

Afterwards, EL-Said and EL-Hamid (2008) compare the reliability of two systems with preventive maintenance and different modes. Haggag (2009) operate two unit cold standby systems with common cause failures and preventive maintenance and used Kolmogorov forward equation method. Mathewi et al (2011) work on 2-unit parallel cc plant system operative with full installed and analysis reliability of system. Shakuntla *et al*(2011) analysis reliability for Polytube industry and used supplementary variable technique and MATLAB.

Further, Yusuf and Hussaini(2012) compare three identical unit redundant systems with three types of failures and applied Kolmogorov's forward equation. Sherbeny and Hussaini (2012) evaluate reliability of mixed standby components. Yusuf and Hussiani (2012) evaluate of reliability characteristic of 2-out of 3 standby systems under a perfect repair condition. Ram and Singh (2012) analyse cost benefits of system under head of line repair approach and used Gumbel-Hougaard Family copula.

Further, the reliability and cost-benefit for a single unit system by introducing the concept of scheduled maintenance with variation in demand has been analyzed by Taneja and Malhotra (2013). Pathak *et al* (2013) studied one main unit and two supporting unit and used regenerative processes. Kadyan (2013) studied a single unit system with preventive maintenance and analyse reliability and profit. Ram *et al* (2013) operates a standby system with waiting repair strategy. Yusuf and Bala (2013) evaluate 2-out-of-4 warm standby system for MTSF. Bhatti *et al* (2013) perform on identical parallel system with failure followed by inspection policy and used discrete distribution. Singh and Dubey (2013) analyse reliability of standby redundant system with critical human errors. On the other hand Yusuf and Yusuf (2013) discussed some reliability characteristics system under

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

three types of failures with repair-replacement at failure. Yusuf and Koki (2013) studied 2-stage deteriorating linear consecutive 2-out-of-3 repairable system.

Kumar and Kapoor (2014) discussed BTS considering software based hardware failure and congestion of cells. Niwas *et al* (2014) studied mtsf and profit for single unit system with inspection and consider feasibility of repair beyond warranty. Yusuf *et al* (2014) studied profit between three dissimilar repairable redundant systems using supporting external device for operation. Munjal and Singh (2014) analyze complex repairable system composed of two 2-out-of-3: G subsystems connected in parallel. Ali and Yusuf (2014) work on 2-out-of-4 repairable system with exchangeable unit and analyze availability and profit of model. Soni *et al* (2014) handles M out of N warm standby system with repair facilities. Haggag (2014) performs repairable redundant 3-out-of-4 system involving preventive maintenance. EL-Damcese and Shama (2014) studied 2-state repairable system with two types of failure for reliability and availability. Ahmad and Kumar (2014) studied 2-unit centrifuge system and consider the halt state on occurrence of minor/major fault. Kumar *et al* (2014) studied the behavior of a cold standby system with maximum repair time. Negi and Singh (2014) analyze non-repairable complex system with weighed subsystems in series. Further, Malhotra and Taneja (2015) compared two stochastic models by introducing the concept of inspection and scheduled maintenance with production depending on demand. Bhatti *et al* (2015) works on dissimilar standby system with discrete failure.

Further, Sharma and Sharma (2016) studied on standby system with provision of concomitant working. Kakkar et al. (2016) discussed two dissimilar parallel unit repairable systems with failure during preventive maintenance. Further, Taneja et al. (2016) discussed the comparison of a single unit system with scheduled maintenance and a two-unit cold standby system where both the units may become operative depending on the demand. Singh and Ayagi (2016) studied reliability measure of system consisting of two subsystems in series and used copula. Singh *et al* (2016) analyze complex system in series configuration under different failure and repair and used copula for repair discipline. Mortazavi *et al* (2016) studied 2-out-of-3 redundant system for evaluating mttf and consider common cause of failure and load share based on alpha factor and capacity flow models. Moreover, Bhardwaj and Singh (2016) studied model of a cold standby by system with waiting for arrival and server of treatment. Kumar and Goel (2016) analyze two units for cold standby system and discussed general distribution. Kumar and Saini (2016) studied on single unit system and applied Weibull failure and repair distribution. Fagge et al. (2017) discussed the availability of a repairable system requiring two types of supporting device for operations. Singh et al. (2017) discussed the cost-benefit analysis of two non-identical units cold standby system subject to heavy rain with partially operative after repair. Mahmoud *et al* (2017) operate on duplicated standby system. Busra et al. (2017) evaluated various maintenance policies for systems subject to continuous-time Markovian deterioration, which may result in non-self-announcing failures. The decision maker inspects the system periodically at the decision epochs, identifies the current state, i.e., good, poor, or failed, and chooses an available action. In this paper authors study the relation between measure of effectiveness (such as MTSF, Availability, Busy period of repairmen and Profit function) and various system parameters (such as failure rate, service rate, repair rate, preventative maintenance rate, operative time, etc) shown in table 1. On the other hand authors also discussed various distribution used by different authors shown in table 2 and table 3.

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 04, April 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

II. NOTATIONS

A. Failure rate
B. Service rate
C. Repair rate
D. Preventative Maintenance rate
E. Operative time
F. Breakdown rate
G. Exchange rate
H. Inversely proportional to
I. Directly proportional to

III. TABLE

TABLE 1: Classification on basis of different parameter

Reference	**Parameter**	**A**	**B**	**C**	**E**	**F**	**G**	**H**
[15]	MTSF	I						
	Availability	I						
[16]	PROFIT	I						
[17]	MTSF	I		D				
	PROFIT	I		D				
[18]	MTSF	I						
[19]	MTSF	I		D				
	PROFIT	I		D				
[24]	MTSF	I		D				
[25]	C/MTSF	D	I	I			D	
	C/Availability	I	I	D			D	
[26]	MTSF	I	D	D			I	
[28]	MTSF	I						
	Availability	I						
	PROFIT	I						
[30]	MTSF	I						
	Availability	I						
[31]	MTSF	I						
	PROFIT	I						
[32]	MTSF							
[33]	Availability	I		D				
[34]	MTSF	I		D				

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

	PROFIT	I	D		
	Availability	I	D		
[35]	Availability		D		
	PROFIT		D		
[37]	MTSF	I	D		
	Availability	I	D		
[38]	MTSF		D		
	PROFIT		D		
	Availability		D		
[39]	PROFIT				D
	Availability				I
[42]	MTSF	I	D		
	PROFIT	I	D		
	Availability	I	D		
[43]	MTSF	I	D		
	Availability	I	D		
[44]	MTSF	I	D	D	I
	Availability	I	D	D	I
[45]	MTSF	I			
	Availability	I			
[46]	MTSF	I	D		
[47]	MTSF	I	D		
	PROFIT	I	D		
[48]	MTSF	I			
	Profit				
	Availability	I			
[49]	MTSF	I	D		
	PROFIT	I	D		
	Availability	I	D		
	Busy Period	D	I		
[50]	MTSF	I	D		

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

	PROFIT	I		D			
	Availability	I		D			
	Busy Period	D		I			
[51]	MTSF	I		D			
	Profit	I		D			
[53]	MTSF	I		D			
	Profit	I		D			
	Availability	I		D			
[54]	MTSF	I		D		I	
	PROFIT	I		D		D	
[55]	PROFIT			D			D
	Availability			D			D
[59]	MTSF	I					
	PROFIT	I					
[60]	MTSF	I					
	PROFIT	I					
	Availability	I					
[61]	MTSF	I					
[63]	Availability	I					
	Profit	I					
[64]	MTSF	I		D			
	Profit	I		D			
[65]	C/MTSF	D	I	I		D	
	C/Availability	D	I	I		D	
[66]	MTSF	I					
	PROFIT	I					
[69]	MTSF	I					
	PROFIT				D		
	Availability				I		
[71]	MTSF	I		D			
[72]	MTSF	I	D	D			

	PROFIT	I	D	D	
	Availability	I	D	D	
[75]	MTSF	I			
	PROFIT	I			
	Availability	I			
[76]	MTSF	I		D	
	PROFIT	I		D	
	Availability	I		D	
[77]	MTSF	I			
	PROFIT				D
	Availability				I
[78]	MTSF	I		D	
	PROFIT	I		D	
	Availability	I		D	

TABLE 2: Classification on basis of different distribution for failure rate

Distribution	Failure rate
Exponential	[10]-[12],[16],[17],[19],[24],[26]-[30],[32],[34],[35],[37]-[43],[46],[48]-[50],[52],[53],[57],[61],[69],[70],[71],[73],[78],[79]
Erlang	[7],[8]
Marshall Olkin	[22]
Weibull	[73],[75]
General	[15],[20],[23],[25],[33],[44],[45],[55],[72]
Geometric	[47],[64]
Gumbel –Hougaard family of copula	[54]
Rayleigh	[56],[73]

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

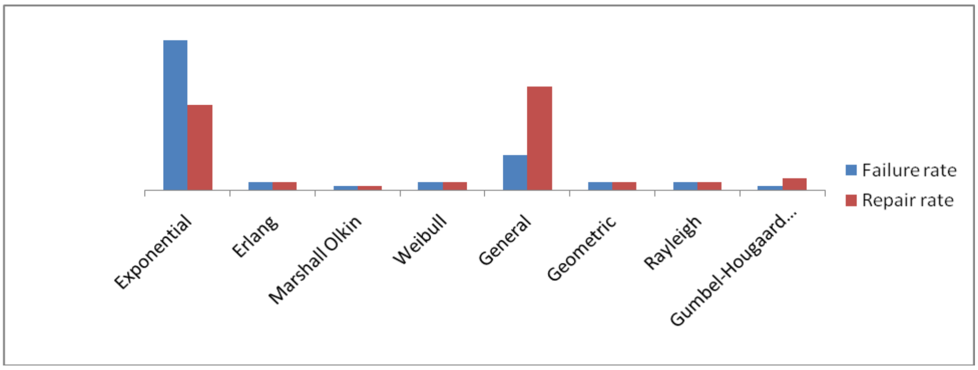
TABLE 3: Classification on basis of different distribution for repair rate

Distribution	Repair rate
Exponential	[16],[20],[24],[26],[30],[34],[35],[37]-[39],[46],[49],[50],[53],[57],[58],[60],[61],[70],[71],[73],[79]
Erlang	[7],[8]
Marshall Olkin	[22]
Weibull	[73],[75]
General	[11],[12],[15],[17],[19],[23],[25],[27]-[29],[32],[33], [40], [42],[43],[44],[45],[48],[51], [52],[55],[59], [63],[69], [70], [72],[78]
Geometric	[47],[64]
Gumbel-Hougaard family of copula	[45],[54],[69]
Rayleigh	[56],[73]

IV. CONCLUSION

In this paper, various reliability measures such as availability, busy time of repairmen, MTSF and profit function are discussed with respect to failure rate, repair rate, service rate, etc. from table, we analyze that

- MTSF decrease with increase in the value of these parameters failure rate, operative rate and breakdown rate. On the contrary MTSF increases with increase in the value of these parameters repair rate, service rate, preventative maintenance rate and exchange rate.
- Availability of system increase with increase in the value of service rate, repair rate, preventative maintenance and exchange rate. However, availability of system decreases with increase in the value of failure rate, operative rate and breakdown rate.
- Rise in the value of failure rate, decrease the profit of system while increase in the value of service rate, repair rate, operative time and exchange rate also increase the profit of the system. According to authors point of view they conclude from table 2 and table 3 in graph no. of reference vs different distribution



V. REFERENCES

[1.] D. J. Davis An analysis of some failure data, *J. Amer. Statist. Assoc., 47*, 1952, 113-150

[2.] Epstein and M. Sobel Sequential life tests in the exponential case, *Annals of Mathematical Statistics 28*, 1955, 82-93

[3.] P. Gaver Time to failure and availability of parallel system with repair, *IEEE Trans. Reliab. 12*, 1964, 30-38

[4.] G. I. Sandler System reliability engineering (Prentice-Hall, Englewood Cliffs, 1963)

[5.] R. E. Barlow and F. Proschan Mathematical theory of reliability (John Wiley, New York, 1965)

[6.] S. K. Srinivasan and M.N. Gopalan Probabilistic analysis of a two unit system with warm standby and single repair facility, *Operations Research 21*, 1973, 748-754

[7.] R. Ramanarayanan, K. Usha n-Unit warm standby system with erlang failure and general repair and its dual, *IEEE* Trans. Reliab., *28*(2),1979, 173-174

[8.] R. Ramanarayanan, K. Usha Two n-unit cold-standby systems with an erlang distribution *IEEE Transactions On Reliability*, *29*(5), 1980, 434-435

[9.] Kumar and M. Agarwal A Review of standby redundant systems *IEEE transactions on reliability 29*(4), 1980, 290-294

[10.] M. Yamashiro A repairable system with N failure modes and K standby units" *Microelectronics and reliability 22*(1), 1982, 53-57

[11.] M. N. Gopalan and R. Naidu Busy-period analysis of a 1-server 2-unit system subject to non-negligible inspection time *Microelectronics and Reliability 23*, 1983, 453-465

[12.] Rastogi AK and Kumar A Effect of intermittent repair in a two unit redundant system with standby failure *Microelectronics and Reliability 23*(6), 1983, 1051-1054

[13.] Murari, V. Goyal and S. Rani Cost analysis in two-unit warm standby models with a regular repairman and patience time, *Microelectron. Reliability 25*(3), 1985, 473-483

[14.] R. D. Yearout, P. Reddy and D. L. Grosh Standby redundancy in reliability - a review *IEEE Transactions On Reliability*, *35*(3), 1986, 285-292

[15.] L. R. Goel and S. C. Sharma Stochastic analysis of a 2- unit standby system with two failure modes and slow switch, *Microelectron. Reliability 29*(4), 1987, 493-498

[16.] L. R. Goel and P. Shrivastava Profit analysis of a two-unit redundant system with provision for rest and correlated failures and repairs *Microelectronics and Reliability*, *31*(5), 1990, 827-833

[17.] R. Gupta and R. Goel Profit analysis of a two-unit cold standby system with abnormal weather condition *Microelectronics and Reliability*, *31*(1), 1991, 1-5

[18.] R. Gupta, S. Bansal Profit analysis of a two unit priority standby system subject to degradation Int.J.Systems Sci., *22(1)*, 1991, 61-72

[19.] R. K. Tuteja and G. Taneja Cost-benefit analysis of a two-server, two-unit, warm standby system with different types of failure *Microelectron. Reliab. 32(10)*, 1992, 1353-1359

[20.] R. Gupta, A. Chaudhary and R. Goel Profit analysis of a two-unit priority standby system subject to degradation and random shocks, *Microelectron. Reliab. 33(8)*, 1993, 1073-1080

[21.] K. F. Martin A review by discussion of condition monitoring and fault diagnosis in machine tools *Int. J. Mach. Tools Manufacturing 34(4)*, 1994, 527-551

[22.] S. P. Rajamanickam and B. Chandrasekar Reliability measures for two-unit systems with a dependent structure for failure and repair times *Microelectronics and Reliability*, *37(5)*, 1997, 829-833

[23.] W. Li, A. S. Alfa and Y. Q. Zhao Stochastic analysis of a repairable system with three units and two repair facilities *Microelectronics and Reliability*, *38(4)*, 1998, 585-59

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346
[24.] J. Ke and K. Wang The reliability analysis of balking and reneging in a repairable system with warm standbys *Qual. Reliab. Engng. Int. 18*, 2002, 467-478

[25.] M. K. El-Said and M. S. EL-Sherbeny Profit analysis of a two unit cold standby system with preventive maintenance and random change in units *Journal of Mathematics and Statistics 1(1*), 2005, 71-77

[26.] K. Wang, J. Ke and W. Lee Reliability and sensitivity analysis of a repairable system with warm standbys and R unreliable service stations *Int J Adv Manuf Technol 31*, 2006, 1223–1232

[27.] K. Wang and L. Chiu Cost benefit analysis of availability systems with warm standby units and imperfect coverage *Applied Mathematics and Computation 172*, 2007, 1239–1256

[28.] J. Nilsson and L. Bertling Maintenance management of wind power systems using condition monitoring systems—life cycle cost analysis for two case studies *IEEE Transactions on Energy Conversion, 22 (1),* 2007, 223-229

[29.] B. Parashar and G. Taneja Reliability and profit evaluation of a PLC hot standby system based on a master-slave concept and two types of repair facilities *IEEE Transactions on Reliability 56 (3),* 2007, 534-539

[30.] M. K. El-Said, R. A. EL-Hamid Comparison of reliability characteristics of two systems with preventive maintenance and different modes *Information and Management Sciences 19(1),* 2008, 107-118

[31.] M. Y. Haggag Cost analysis of a system involving common cause failures and preventive maintenance *Journel of Mathematics and Statistics 5(4),* 2009, 305-310

[32.] A. G. Mathew, S. Rizwan, M. C. Majumder, K. P. Ramachandran and G. Taneja Reliability analysis of an identical two-unit parallel CC plant system operative with full installed Capacity *International Journal of Performability Engineering 7(2),* 2011, 179-185

[33.] S. Shakuntla, A. K. Lal, S. S. Bhatia and J. Singh Reliability analysis of Polytube industry using supplementary variable technique *Applied Mathematics and Computation 218,* 2011,3981–3992

[34.] I. Yusuf and N. Hussaini A comparative analysis of three unit redundant systems with three types of failures *Arab J Sci Eng 39(4)*, 2012, 3337-3349

[35.] I. Yusuf and N. Hussaini Evaluation of reliability and availability characteristics of 2-out of -3 standby system under a perfect repair condition *American Journal of Mathematics and Statistics 2(5),* 2012, 114-119

[36.] L. Jiang, Q. Feng and D. W. Coit Reliability and maintenance modeling for dependent competing failure processes with shifting failure thresholds Institute of Electrical and Electronics Engineers, *61(4),* 2012, 932–948

[37.] M. S. EL-Sherbeny and E. K. AL-Hussaini Characteristic reliability measures of mixed standby components and asymptotic estimation *International Journal of Statistics and Applications 2(3),* 2012, 11-23

[38.] I. Yusuf and N. Hussaini Evaluation of reliability and availability characteristics of 2-out of -3 standby system under a perfect repair condition *American Journal of Mathematics and Statistics 2(5),* 2012, 114-119

[39.] M. Ram and S. B. Singh Cost benefit analysis of a system under head of-Line repair approach using gumbel hougaard Family copula *Journal of Reliability and Statistical Studies 5(2),* 2012, 105-118

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346
[40.] G. Taneja and R. Malhotra Cost-benefit analysis of a single unit system with scheduled maintenance and variation in demand, *Journal of Mathematics and Statistics 9(3),* 2013, 155-160

[41.] R. Malhotra and G. Taneja Reliability and availability analysis of a single unit system with varying demand, *Mathematical Journal of Interdisciplinary Sciences 2(1),* 2013, 77-88

[42.] V. K. Pathak, K. Mehta, S. Sahu and R. Chaturvedi Profit analysis of a system having one main unit and two supporting unit international *Journal Of Engineering And Computer Science 2,* 2013, 01-13

[43.] V. K. Pathak, K. Mehta and S. Sahu Performance analysis of a system having one main unit and two supporting units *International Journal Of Mathematics And computer Research 1(7),* 2013, 174-188

[44.] M. S. Kadyan Reliability and Profit analysis of a single-unit system with preventive maintenance subject to maximum operation time *Maintenance and Reliability 15(2),* 2013, 176–181

[45.] M. Ram, S. B. Singh and V. V. Singh Stochastic analysis of a standby system with waiting repair strategy *IEEE Transactions On Systems, Man, And Cybernetics: Systems, 43(3),* 2013

[46.] I. Yusuf and S. I. Bala Modeling and evaluation of mtsf of a repairable 2-out-of-4 warm standby system attended by repair machines and repairmen *Engineering Mathematics Letters 2(2),* 2013,81-89

[47.] J. Bhatti, A. K. Chitkara and M. Kakkar Analysis of identical parallel system with failure followed by inspection policy using discrete distribution *International Journal of Scientific & Engineering Research 4(5),* 2013

[48.] R. P. Singh and G. K. Dubey Reliability and cost analysis of a stand by redundant system with critical human errors *International Journal of Engineering and Mathematical Sciences 4(1),* 2013, 25 – 33

[49.] B. Yusuf and I. Yusuf Evaluation Some reliability characteristics of a system under three types of failures with repair-replacement at Failure *American Journal of Operational Research 3(3),* 2013, 83-91

[50.] I. Yusuf and F. S. Koki Assessment of profit of a two-stage deteriorating linear consecutive 2-out-of-3 repairable system *Journal of Applied Mathematics and Physics,1,* 2013, 21-27

[51.]]R. Kumar and S. Kapoor Profit evaluation of a stochastic model on base transceiver system considering software based hardware failures and congestion of calls *International Journal of Application or Innovation in Engineering & Management, 2(3),* 2013, 554-562

[52.] R. Niwas, M. S. Kadyan and J. Kumar MTSF (mean time to system failure) and profit analysis of a single-unit system with inspection for feasibility of repair beyond warranty *Int J Syst Assur Eng Manag 7(1),* 2014, 198-204

[53.] I. Yusuf, K. Suleiman and Y. Bashir Stochastic modelling and analysis of a repairable 2-out-of-4 system *Int. J. Mathematics in Operational Research 6(1),* 2014

[54.] A. Munjal and S. B. Singh Reliability analysis of a complex repairable system composed of two 2-out-of-3: g subsystems connected in parallel *Journal of Reliability and Statistical Studies 7,* 2014, 89-111

[55.] U. A. Ali and I. Yusuf Availability and profit analysis of a linear consecutive 2-out-of-4 repairable system with units exchange *American Journal of Applied Mathematics and Statistics, 2(2),* 2014, 83-87

[56.] K. Soni, U. R. Singh and R. Jha Mathematical analysis of reliability of M out Of N warm stand by system with repair facilities *International Journal of Advance Research and Innovation 2(4),* 2014, 744-749

[57.] M.Y. Haggag Profit Analysis and availability of a repairable redundant3-out-of-4system involving preventive maintenance *International Journal of Scientific & Engineering Research 6(8),* 2015, 1161-1173

[58.] M. A. El-Damcese, M. S. Shama Reliability and availability analysis of a 2-state repairable system with two types of failure *Eng. Math. Lett*., *2*, 2014, ISSN: 2049-9337

[59.] S. Ahmad and V. Kumar Profit analysis of a two-unit centrifuge system considering the halt state on occurrence of minor/ major fault *International Journal of Advanced Research in Engineering and Applied Sciences 4(4)*,2015

[60.] A. Kumar, S. Baweja and M. S. Barak Stochastic behavior of a cold standby system with maximum repair time *Decision Science Letters 4*, 2015, 569–578

[61.] S. Negi and S. B. Singh Reliability analysis of non repairable complex system with weighted subsystems connected in series *Applied Mathematics and Computation 262*, 2015, 79–89

[62.] R. Malhotra and G. Taneja Comparative analysis of two stochastic models subjected to inspection and scheduled maintenance, *International Journal of Software Engineering and Its Applications 9(10)*, 2015, 179-188

[63.] R. Malhotra, G. Taneja Comparative study between a single unit system and a two‑unit cold standby system with varying demand *Springer Plus 4*, 2015, 705

[64.] J. Bhatti, A. K. Chitkara and M. K. Kakkar Stochastic analysis of dissimilar standby system with discrete failure, inspection and replacement policy *Demonstration Mathematical*, *49(2)*, 2015

[65.] M. Babagana, B. Gimba and I. Yusuf Introducing probabilistic models for redundant system reliability *Operations research and decisions DOI: 10.5277/ord160101*,2016

[66.] U. Sharma, G. Sharma Probabilistic Analysis of a Standby System with Provision of Concomitant Working *International Journal of Engineering Trends and Technology 40(1)*,2016

[67.] M. K. Kakkar, A. K. Chitkara and J. Bhatti Reliability analysis of two dissimilar parallel unit repairable system with failure during preventive maintenance, *Management Science* Letter *6, 2016*, 285-296.

[68.] G. Taneja, R. Malhotra and A. K. Chitkara Comparative profit analysis of two reliability models with varying demand, *Arya Bhatta J. of Math & Info*. *8(2)*, 2016, 305-314.

[69.] V. V.Singh, I. Ayagi Study of reliability measures of system consisting of two subsystems in series configuration using copula 2016, 1-14

[70.] V. V. Singh, J. Gulati, D. K. Rawal and C. K. Goel Performance analysis of complex system in series configuration under different failure and repair discipline using copula *International Journal of Reliability, Quality and Safety Engineering 23(2)*,2016

[71.] S. M. Mortazavi, M. Karbasian and S. Goli Evaluating MTTF of 2-out-of-3 redundant systems with common cause failure and load share based on alpha factor and capacity flow models *Int J Syst Assur Eng Manag* 2016

[72.] R. K. Bhardwaj and R. Singh Stochastic model of a cold-stand by system with waiting for arrival & treatment of server *American Journal of Operations Research 6*, 2016,334-342

[73.] J. Kumar and M. Goel Availability and profit analysis of a two-unit cold standby system for general distribution *Cogent Mathematics 3(1)*, 2016,

[74.] E. Zio Some challenges and opportunities in reliability engineering, *Institute of Electical and Electronics Engineers 65(4)*, 2016, 1769-1782

[75.] A. Kumar and M. Saini Analysis of a single-unit system with weibull failure and repair densities subject to server failure *Malaysian Journal of Science 359(1)*,2016, 15 - 22

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346
[76.] I. Yusuf Reliability modeling of a parallel system with a supporting device and two types of preventive maintenance *Int. J. Operational Research*, *25(3),* 2016

[77.] N. J. Fagge, I.Yusuf and U. A. Ali Availability evaluation of repairable system requiring two types of supporting device for operations *International Journal of Applied Mathematical Research 6 (1),* 2017, 14-19

[78.] N. Singh, D. Singh and A. K. Saini Cost-Benefit analysis of two non-identical units cold standby system subject to heavy rain with partially operative after repair *Global Journal of Pure and Applied Mathematics*, *13*, 2017,137-147

[79.] M. A. W. Mahmoud, M. Y.Haggag and A. E. B. Abd Elghany Stochastic analysis of a duplicated standby system subject to shocks during repair *Journal of the Egyptian Mathematical Society 25(2),* 2017, 186-190.

[80.] K. Busra¸ T. Salih and O. B. Niyazi Maintenance policies for a deteriorating system subject to non-self-announcing failures, *IEEE Trans. Rel.*, *66(1)*, 2017, 219-232.