



## INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATION AND MANAGEMENT

### CONTENTS

Sr. No.	TITLE & NAME OF THE AUTHOR (S)	Page No.
1.	ORGANIZATIONAL STORYTELLING: CONCEPTS, CHARACTERISTICS AND ADVANTAGES <i>SKANDAR SHIRAZI, HAMIDEH SHEKARI &amp; SAID MEHDI VEYSEH</i>	1
2.	EXAMINING THE EFFECT OF COMPANY'S SIZE AND RESOURCES ON THE RELATIONSHIP BETWEEN STAKEHOLDERS' PRESSURE AND ENVIRONMENTAL STRATEGIES IN THE MALAYSIAN PALM OIL INDUSTRY <i>MOHD RAFI YAACOB</i>	5
3.	CORPORATE GOVERNANCE AND FINANCIAL REPORTING QUALITY: A STUDY OF NIGERIAN MONEY DEPOSIT BANKS <i>SHEHU USMAN HASSAN</i>	12
4.	AN EMPIRICAL STUDY ON TAX PAYER'S ATTITUDE TOWARDS E- RETURN FILING IN INDIA <i>DR. SUJEET KUMAR SHARMA &amp; DR. RAJAN YADAV</i>	20
5.	SPATIAL ANALYSIS OF LAND USE IN MYSORE CITY <i>DR. HARISH. M</i>	25
6.	DRIVERS OF NEW PRODUCT SUCCESS <i>K. VIJAYAN &amp; DR. JAYSHREE SURESH</i>	30
7.	KNOWLEDGE MANGEMENT FOR PERFORMANCE EXCELLENCE <i>DR. S. RAMANATHAN &amp; DR. S. SELVAMUTHUKUMARAN</i>	35
8.	A NEW PARADIGM IN DESIGNING AN ADVERTISEMENT - AN APPLICATION OF REAL TIME DATA WAREHOUSE & DATA MINING IN PREPARATION OF AN AD COPY <i>DR. G. VADIVALAGAN, N. SUGANTHI &amp; M. RAMESHKUMAR</i>	39
9.	UNETHICAL PRACTICE OF MIS-SELLING OF INSURANCE – IMPACT AND SOLUTIONS <i>C. BARATHI, DR. CH. IBOHAL MEITEI &amp; C. D. BALAJI</i>	45
10.	BUSINESS PROCESS DEVELOPMENT IN SERVICE ORIENTED ARCHITECTURE <i>C. K. GOMATHY &amp; DR. S. RAJALAKSHMI</i>	50
11.	VARIANCE OF THE TIME TO RECRUITMENT IN A SINGLE GRADED MANPOWER SYSTEM – SCBZ PROPERTY <i>R. ARUMUGAM &amp; DR. A. PANDURANGAN</i>	54
12.	SURVEY - 3D FACE TRACKING <i>SUSHMA JAISWAL, DR. SARITA SINGH BHADAURIA &amp; DR. RAKESH SINGH JADON</i>	57
13.	AN EMPIRICAL EVALUATION OF INVESTORS INCLINATION ON ULIP INSURANCE PRODUCTS WITH REFERENCE TO DELHI CITY <i>R. SERANMADEVI, DR. M. G. SARAVANARAJ &amp; DR. M. LATHA NATARAJAN</i>	79
14.	A STUDY ON THE TRAFFIC PROBLEMS WITH SPECIAL REFERENCE TO NELLORE DISTRICT <i>KANAGALURU SAI KUMAR</i>	84
15.	A STUDY ON LEAN MANAGEMENT IN CHENNAI PORT <i>R. AKILA &amp; DR. N. THANGAVEL</i>	89
16.	CONSUMER PREFERENCE FOR COSMETICS AMONG COLLEGE GIRLS IN TIRUNELVELI AND THOOTHUKUDI DISTRICTS <i>P. DEVIBALA &amp; DR. A. RANGASWAMY</i>	94
17.	MANAGING NON PERFORMING ASSETS: A STUDY OF INDIAN COMMERCIAL BANKS <i>DR. HIMANSHU SHEKHAR SINGH &amp; DR. AJAY SINGH</i>	99
18.	EMPOWERMENT OF RURAL ODISHA THROUGH CONNECTIVITY (WITH SPECIAL REFERENCE TO KHURDA DISTRICT OF ODISHA) <i>DR. IPSEETA SATPATHY, DR. B. CHANDRA MOHAN PATNAIK &amp; PRABIR KUMAR PRADHAN</i>	103
19.	CHOICE OF CAPITAL STRUCTURE MODEL: AN EMPIRICAL ANALYSIS WITH REFERENCE TO STATIC TRADE-OFF VS PECKING ORDER THEORIES IN BEVERAGE AND ALCOHOL INDUSTRY IN INDIA <i>RAJU DEEPA &amp; DR. RAMACHANDRAN AZHAGAIAH</i>	107
20.	EFFECTIVE MARKETING STRATEGY FOR SMALL SCALE PLASTIC PROCESSING UNITS IN M. I. D. C., JALGAON <i>PRASHANT S. WARKE</i>	112
21.	BUSINESS OPPORTUNITIES AND TRENDS IN INDIA - 'SILVER MARKET AND YOUTH PREMIUM MARKET' <i>DR. M. A. LAHORI</i>	117
22.	JIT BASED QUALITY MANAGEMENT IN INDIAN INDUSTRIES <i>SANDEEP MALIK, NISHANT PAHWA &amp; DR. DINESH KHANDUJA</i>	120
23.	RECENT CASE STUDIES OF RISK IN INFORMATION SECURITY <i>DR. S. KANCHANA RATNAM &amp; T. T. RAJKUMAR</i>	123
24.	RELATIONSHIP BETWEEN JOB STRESS AND EMPLOYEES PERFORMANCE IN DAY TO DAY OPERATIONS OF PRIVATE ORGANIZATIONS AND THE IMPACT OF STRESS ON THE OVERALL PERFORMANCE OF EMPLOYEE <i>VIJAY KUMAR GUPTA</i>	126
25.	CONSUMER AWARENESS TOWARDS MOBILE - BANKING AMONG WORKING PROFESSIONALS <i>RAJAN GIRDHAR &amp; NIDHI BHARDWAJ</i>	134
	REQUEST FOR FEEDBACK	140

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# VARIANCE OF THE TIME TO RECRUITMENT IN A SINGLE GRADED MANPOWER SYSTEM – SCBZ PROPERTY

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## ABSTRACT

*In this paper, the expected time to recruitment in a single graded system is obtained by assuming that the two threshold variables which satisfy the setting the clock back to zero property. The analytical results are numerically illustrated and relevant conclusions are presented.*

## KEYWORDS

Manpower planning, graded system, threshold, SCBZ property, mean and variance of the time to recruitment.

## INTRODUCTION

Manpower planning is an attempt to match the supply of people with the jobs available for them. It can be viewed as a process by which management determines how the organization should move from current manpower structure to a desired one. In the study of manpower planning one important concept of study is relating to wastages of man power. Many models have been discussed using different kinds of wastages and also different types of distributions. Such models could be seen in Grinold and Marshall 1977 and Bartholomew and Forbes 1979. Many researches Sathiyamoorthy, R. and Elangovan, R, 1998, Karlin Samuel and Taylor, M. Hayward, 1981, Sathiyamoorthy, R. and Parthasarathy, S, 2003, Srinivasan, A and Saavithrei, V, 2002, Chitrakalarani, T and Samundeeswari, D, December 2010 have considered the problem of time for recruitment in a single graded marketing organization involving only one threshold under different conditions. Since the number of exits in a policy decision making epoch is unpredictable and the time at which the cumulative loss of man hours crossing a single threshold is probabilistic, the organization has left with no choice except making recruitment immediately upon the threshold crossing. In this paper, this limitation is removed by considering the following new recruitment policy involving two thresholds in which optional threshold; the organization may or may not go for recruitment. However, recruitment is necessary whenever the cumulative loss of manhours crosses the mandatory threshold. In view of this policy, the organization can plan its decision upon the time for recruitment. For a single graded system involving the optional and mandatory thresholds, the mean and variance of the time to recruitment are obtained in this paper, using the above cited recruitment policy. The concepts and tool in stochastic process have found applications in disciplines like biology, medicine, engineering, economics, demography, etc. One of the most important problems in stochastic process is to identify the underlying model which generates the observation when only the data on failure times is available. Some innovations in this regard are to identify a characteristic property of the distribution that is of interest. From this point of view, we change our direction to a new property which is called Setting the Clock Back to Zero (SCBZ) property

## MODEL DESCRIPTION

Consider an organization taking decisions at random epochs in  $(0, \infty)$  and at every decision making epoch a random number of persons quit the organization. There is an associated loss of manhours to the organization if a person quits. It is assumed that the losses of manhours are linear and cumulative. Let  $X_i$  be the loss of manhours due to the  $i^{\text{th}}$  decision epoch,  $i=1,2,3,\dots$  forming a sequence of independent and identically distributed random variables. Let  $g(\cdot)$  be the probability density function of  $X_i$ ,  $i=1,2,3,\dots$ . It is assumed that the inter-decision times are independent and identically distributed random variables with probability density function  $f(\cdot)$  (and cumulative distribution function  $F(\cdot)$ ). Let  $f_k(\cdot)$  ( $F_k(\cdot)$ ) be the  $k$  fold convolution of  $f(\cdot)$  ( $F(\cdot)$ ). Let  $f^*(\cdot)$  ( $g^*(\cdot)$ ) be the Laplace transform of  $f(\cdot)$  ( $g(\cdot)$ ). Suppose that the loss of manhours process and the process of inter-decision times are statistically independent. Let  $Y$  ( $Z$ ) be a positive continuous random variable denoting the optional (mandatory) threshold following exponential distribution with parameter  $\mu_1$  ( $\mu_2$ ) such that  $Z > Y$ . Let  $p$  be the probability that the organization is not going for recruitment whenever the total loss of manhours crosses the optional level  $Y$ . If the total loss of manhours exceeds the optional threshold level the organization may or may not go for recruitment, but if the total loss of manhours exceeds the mandatory threshold recruitment is necessary. This is the recruitment policy employed in this paper. Let  $W$  be a continuous random variable denoting the time for recruitment in the organization with probability density function  $l(\cdot)$  and cumulative distribution function  $L(\cdot)$ . Let  $V_k(t) = F_k(t) - F_{k+1}(t)$  be the probability that there are exactly  $k$ -decision epochs in  $[0, t]$  where  $F_0(t) = 1$ . Let  $E(W)$  be the expected time for recruitment and  $V(W)$  be the variance of the time for recruitment.

## MAIN RESULTS

The survivor function of  $W$  is given by

$$P(W > t) = \sum_{k=0}^{\infty} \left\{ \begin{array}{l} \text{(Probability of exactly } k \text{ decision in } [0, t], k = 0, 1, 2, \dots \times \text{(the probability of total} \\ \text{number of exists in these } k \text{- decisions does not cross the optional level } Y \text{ or the} \\ \text{probability of total number of exist in these } k \text{- decisions cross the optional level } Y \\ \text{but lies below the mandatory level } Z \text{ and the organization is not making recruitment)} \end{array} \right.$$

$$P(W > t) = \sum_{k=0}^{\infty} V_k(t) P\left(\sum_{i=1}^k X_i < Y\right) + \sum_{k=0}^{\infty} V_k(t) \times p \times P\left(Y \leq \sum_{i=1}^k X_i\right) \times P\left(\sum_{i=1}^k X_i < Z\right) \quad (1)$$

By the law of total probability, for  $i=1, 2, 3 \dots$

$$P(X_i < Y) = \int_0^{\infty} e^{-\mu_1 x} g(x) dx = g^*(\mu_1)$$

$$\therefore P\left(\sum_{i=1}^k X_i < Y\right) = [g^*(\mu_1)]^k \quad (2)$$

$$P\left(\sum_{i=1}^k X_i < Z\right) = [g^*(\mu_2)]^k \quad (3)$$

Using (2) and (3) in (1) and on simplification we get,

$$P(W > t) = 1 + [g^*(\mu_1) - 1] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_1)]^{(k-1)} + p x [g^*(\mu_2) - 1] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_2)]^{(k-1)} \\ - p x [g^*(\mu_1) g^*(\mu_2) - 1] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_1) g^*(\mu_2)]^{(k-1)} \quad (4)$$

Since  $L(t) = 1 - P(W > t)$ , from (4)

$$L(t) = [1 - g^*(\mu_1)] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_1)]^{(k-1)} + p x [g^*(\mu_2)] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_2)]^{(k-1)} \\ - p x [g^*(\mu_1) g^*(\mu_2) - 1] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_1) g^*(\mu_2)]^{(k-1)} \\ \therefore l(t) = [1 - g^*(\mu_1)] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_1)]^{(k-1)} + p x [g^*(\mu_2)] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_2)]^{(k-1)} \\ - p x [g^*(\mu_1) g^*(\mu_2) - 1] \sum_{k=1}^{\infty} F_k(t) [g^*(\mu_1) g^*(\mu_2)]^{(k-1)} \\ l^*(s) = \left[ \frac{[1 - g^*(\mu_1)] f^*(s)}{1 - f^*(s) g^*(\mu_1)} \right] + \left[ \frac{p x [1 - g^*(\mu_2)] f^*(s)}{1 - f^*(s) g^*(\mu_2)} \right] - \left[ \frac{p x [1 - g^*(\mu_1) g^*(\mu_2)] f^*(s)}{1 - f^*(s) g^*(\mu_1) g^*(\mu_2)} \right] \quad (5)$$

and

$$E(W) = \left[ \frac{-d}{ds} l^*(s) \right]_{s=0} \quad \text{and} \quad E(W^2) = \left[ \frac{-d^2}{ds^2} l^*(s) \right]_{s=0} \quad \text{from which } V(W) \text{ is obtained.}$$

#### SPECIAL CASE

In this case  $W$  satisfies the SCBZ property with parameter  $\mu_1$  and  $\mu_2$  and assume that  $X \sim \exp(\alpha)$  and  $U \sim \exp(\lambda)$

From (5)

$$l^*(s) = \left[ \frac{\lambda [1 - g^*(\mu_1)]}{\lambda + s - \lambda g^*(\mu_1)} \right] + \left[ \frac{p x \lambda [1 - g^*(\mu_2)]}{\lambda + s - \lambda g^*(\mu_2)} \right] - \left[ \frac{p x \lambda [1 - g^*(\mu_1) g^*(\mu_2)]}{\lambda + s - \lambda g^*(\mu_1) g^*(\mu_2)} \right] \quad (6)$$

$$E(W) = \frac{1}{\lambda} \left[ \left[ \frac{(\alpha + \mu_1)}{\mu_1} \right] + \left[ \frac{p(\alpha + \mu_2)}{\mu_2} \right] - \left[ \frac{p(\alpha + \mu_1)(\alpha + \mu_2)}{[\alpha(\mu_1 + \mu_2) + \mu_1 \mu_2]} \right] \right] \quad \text{on simplification} \quad (7)$$

$$E(W^2) = \frac{2}{\lambda^2} \left[ \left[ \frac{1}{[1 - g^*(\mu_1)]^2} \right] + \left[ \frac{p}{[1 - g^*(\mu_2)]^2} \right] - \left[ \frac{p}{[1 - g^*(\mu_1) g^*(\mu_2)]^2} \right] \right] \quad \text{on simplification} \quad (8)$$

$$\text{and} \quad V(W) = E(W^2) - [E(W)]^2 \quad (9)$$

(7) give the mean time to recruitment and (7) and (8) together with (9) gives the variance of the time for recruitment.

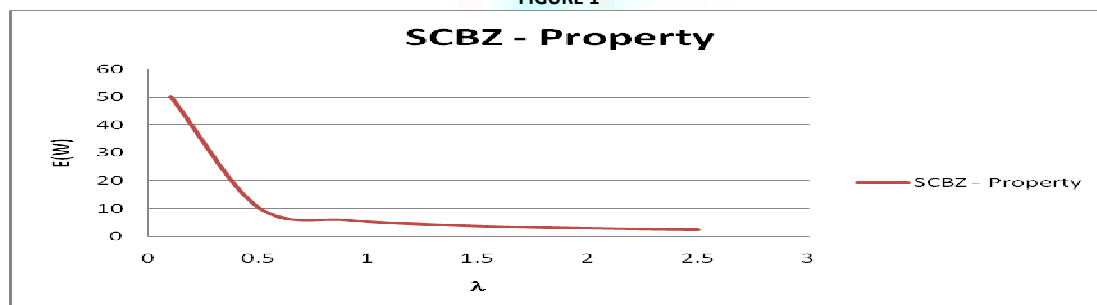
#### NUMERICAL ILLUSTRATION

The analytical expression for expectation and variance of the time to recruitment are analyzed by

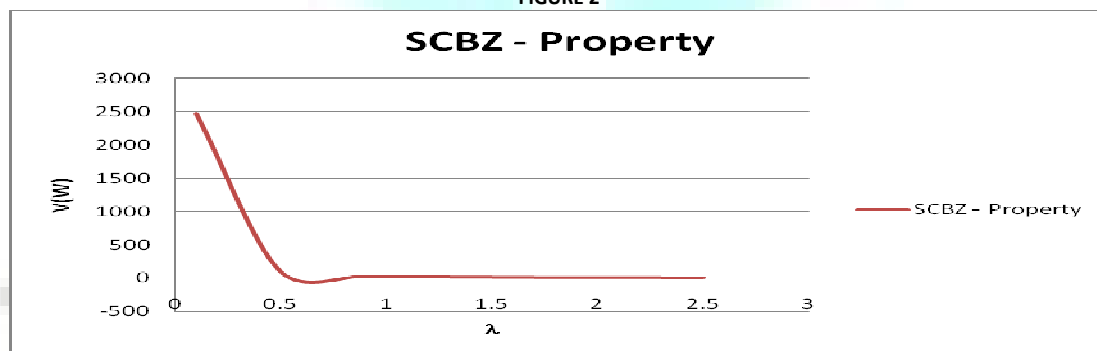
varying parameters. The influence of model parameters  $\lambda$ ,  $\mu_1$  and  $\mu_2$  on performance measures namely mean and variance of the time to recruitment for this model by varying one parameters and keeping the other parameters fixed. In table -1 and table-2 the corresponding results for this model are shown.

**Table - 1** Effect of  $\lambda$ ,  $\mu_1$  and  $\mu_2$  on performance measures ( $\mu_1 = 0.2$ ;  $\mu_2 = 0.06$ ;  $p = 0.03$ ;  $\alpha = 0.8$ )

$\lambda$	$\alpha$	P	$\mu_1$	$\mu_2$	$E(W)$
0.1	0.8	0.03	0.2	0.06	50.313
0.5	0.8	0.03	0.2	0.06	10.313
0.9	0.8	0.03	0.2	0.06	5.868
1.3	0.8	0.03	0.2	0.06	4.158
1.7	0.8	0.03	0.2	0.06	3.254
2.1	0.8	0.03	0.2	0.06	2.693
2.5	0.8	0.03	0.2	0.06	2.313

**FIGURE 1****Table 2:** Effect of  $\lambda$ ,  $\mu_1$  and  $\mu_2$  on performance measures ( $\mu_1 = 0.2$ ;  $\mu_2 = 0.06$ ;  $p = 0.03$ ;  $\alpha = 0.8$ )

$\lambda$	$\alpha$	P	$\mu_1$	$\mu_2$	$E(W)$	$v(w)$
0.1	0.8	0.03	0.2	0.06	50.313	2474.33
0.5	0.8	0.03	0.2	0.06	10.313	99.352
0.9	0.8	0.03	0.2	0.06	5.868	32.996
1.3	0.8	0.03	0.2	0.06	4.158	17.99
1.7	0.8	0.03	0.2	0.06	3.254	12.418
2.1	0.8	0.03	0.2	0.06	2.693	9.787
2.5	0.8	0.03	0.2	0.06	2.313	8.35

**FIGURE 2**

## CONCLUSION

From the above table the expected value of  $W$  and  $\text{Var}(W)$  are obtained using SCBZ property. However, as  $\lambda$  increases the mean and variances are decreasing simultaneously and converge together. This is the behavior of mean and variance of time to breakdown or time to reach uneconomic status when increased tends to shorten the time to breakdown. It is also represented by using graphs.

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