BVG Trust

J. Sci. Trans. Environ. Technov. 2011, 4(4) : 161-163

Scientific Transactions in Environment and Technovation

Time to breakdown point of an organization - Cumulative damage model

A. Yogeswari[1]* and T. Chitrakalarani[2]

[1]Department of Mathematics, Sengamala Thayaar Educational Trust Women's College, Mannargudi - 614 016, Tamil Nadu, India.
[2]Department of Mathematics, K.N.G. Arts College for Women (Autonomous), Thanjavur, Tamil Nadu, India.

Abstract

This paper estimates the expected time to reach the uneconomic status of an organization due to successive occurrence of absenteeism of workers.

Keywords: absenteeism, break down point, cumulative damage, manpower planning, shock model

INTRODUCTION

Absenteeism is a social phenomenon, an industrial malady and a labour problem. Absenteeism refers to the workers absence from his regular task when he is normally scheduled to work. It results in loss of manpower to the organization. It leads to production losses in terms of quantity and quality and earnings are reduced to the organization.

Jensen and Mcintosh (2006) developed a new model of absenteeism behaviour using Danish data from a worker environmental survey. Baladev (1970) examined the relationship between a number of demographic, social and organizational factors and absenteeism using primary data from automobile plant in Bombay. Froidevaux (1973) concludes that absenteeism is not just the result of employee sickness or fatigue but a sign of bad management. Enidperlin (1977) observes that high rate of absenteeism was noticeable on night shifts and in departments where conditions were most unpleasant. Desai (1970) gives analysis of attendance records, the sample survey and case studies of chronic absentees as the methods of organizing a research study on absenteeism. Coles and Treble (1993) extended a model developed by Wises (1985) in which the firms interest in reducing worker absenteeism is reflected in the wage contract it offers to its employees. Esary et al (1973) has considered Shock models and Wear processes. Dasgupta and Pecht (1991) have determined the material failure mechanisams and damage. Chitrakalarani and Ganesan (2002) have developed a stochastic model for the study of cumulative effects of Industrial Accidents. Bhatia (1979) emphasizes the need for quantitative analysis and systematic understanding of the absenteeism problem.

The successive occurrence of absenteeism of workers leads to manpower loss to the organization. If the total loss of manpower exceeds the threshold level, the organization reaches the uneconomic status. The aim of this paper is to estimate the expected time to reach the uneconomic status of an organization due to successive occurrence of absenteeism of workers by using cumulative damage model.

MODEL FORMULATION

Assumptions

- Absenteeism occurs at 'K' random epochs and at every epoch a random number of manpower loss leads to man hours loss to the organization.
- Each absenteeism epoch causes a random loss in man hours. That losses on successive absenteeism epochs are idependently identically distributed (i.i.d) random variables.
- The process which generates the absenteeism epoch, the sequence of loss 'X_i' and the threshold level 'Y' are independent.
- If the total loss exceeds and threshold level 'Y' which itself is a random variable, the organization faces the breakdown point.

Notations

X_i – A i.i.d continuous random variable that denotes the man hours lost due to the i-th absenteeism epoch.

Y – A continuous random variable that denotes the threshold level causing the organization reaches an

*Corresponding Author
email: *yogibharathi@yahoo.com*

uneconomic status. Threshold level 'Y' has an exponential distribution with parameter 'θ'

T – A continuous random variable denoting the time to reach an uneconomic status of an organization.

G(x) – the cumulative distribution function of $X_i = X$ for i = 1, 2……… K and g(x) – corresponding probability density function.

$V_k(t)$ – Probability of exactly 'K' absenteeism epoch occurs in (o, t].

Ui – A continuous random variable denoting the interarrival times between successive absenteeism epochs which has an exponential distribution with parameter C.

$F_k(t)$ – the distribution function of $U_1 + U_2 + \ldots + U_k$

$g_k(t)$ – probability density function of $\sum_{i=1}^{k} X_i$

$g^*(\theta)$ – The laplace transform of g(x).

RESULTS

The probability that the cumulative loss of man hour has not crossed the threshold level in 'K' absenteeism epochs is equal to S_k and.

$$P(T > t) = \sum_{k=0}^{\infty} P \text{ (Exactly k absenteeism epochs in (0,t) and the threshold level is not crossed)}$$

$$= \sum_{k=0}^{\infty} V_k(t)\,[g^*(\theta)]^k$$

$$= \sum_{k=0}^{\infty} (F_k(t) - F_{k+1}(t))\,[g^*(\theta)]^k$$

= S(t) which is the survivor function

$$L(t) = P(T>t)$$

$$= [1-g^*(\theta)] \sum_{k=1}^{\infty} [1-g^*(\theta)]^{k-1} F_k(t)$$

$$L^*(s) = [1-g^*(\theta)] \sum_{k=1}^{\infty} [g^*(\theta)]^{k-1} (f^*(s))^k$$

$$L^*(s) = [1-g^*(\theta)]\, f^*(s) \sum_{k=1}^{\infty} [g^*(\theta)\, f^*(s)]^{k-1}$$

$$= \frac{[1-g^*(\theta)]\, f^*(s)}{[1-g^*(\theta)\, f^*(s)]}$$

$$L^*(s) = \frac{[1-\beta]\,[c/c+s]}{[1-\beta\,(c/c+s)]} \quad \text{Where } \beta = g^*(\theta)$$

$$\text{Mean } \mu_1 = \frac{-d}{ds}\,[L^*(s)]|s=0$$

$$= \frac{1}{c\,[1-\beta]}$$

$$\text{Variance} = \frac{1}{c^2[1-\beta]^2}$$

Special case

If X follows exponential distribution with parameter α

$$g^*(\theta) = \frac{\alpha}{\alpha+\theta}$$

$$\text{Mean} = \frac{\alpha+\theta}{c\theta}$$

$$\text{Variance} = \frac{(\alpha+\theta)^2}{c^2\theta^2}$$

Numerical illustrations :

For variation in 'C' and 'θ' the numerical results are given in Table 1 and 2 which are supported by the graphs in Fig. 1 and 2.

Table 1. Analysis of mean

C	Mean				
	θ = 0.1	θ =0.3	θ =0.5	θ =0.7	θ =0.9
2	5.5000	2.1667	1.5000	1.2143	1.0556
4	2.7500	1.0833	0.7500	0.6071	0.8278
6	1.8333	0.7222	0.5000	0.4048	0.3519
8	1.3750	0.5417	0.3036	0.3036	0.2639
10	1.1000	0.4333	0.2429	0.2429	0.2111

Table 2. Analysis of variance

C	Variance				
	θ = 0.1	θ =0.3	θ =0.5	θ =0.7	θ =0.9
2	30.2500	4.6944	2.2500	1.4745	1.1142
4	7.5625	1.1736	0.5625	0.3686	0.2785
6	3.3611	0.5216	0.2500	0.1638	0.1238
8	1.8906	0.2934	0.1406	0.0922	0.0696
10	1.2100	0.1878	0.0900	0.0589	0.0446

For fixed 'θ' as 'C' increases, the mean time to breakdown decreases. Also if 'C' is fixed and 'θ' increases, the mean time to breakdown decreases. The variance of time to breakdown is also numerically illustrated in table 2. For fixed value of 'θ' as 'C' increases the variance decreases. 'C' is fixed and θ increases again the variance decreases.

The overall conclusion that could be drawn from the behaviour of mean and variance of time to breakdown is that the number of absenteeism epoch when increased tends to shorten the time to breakdown.

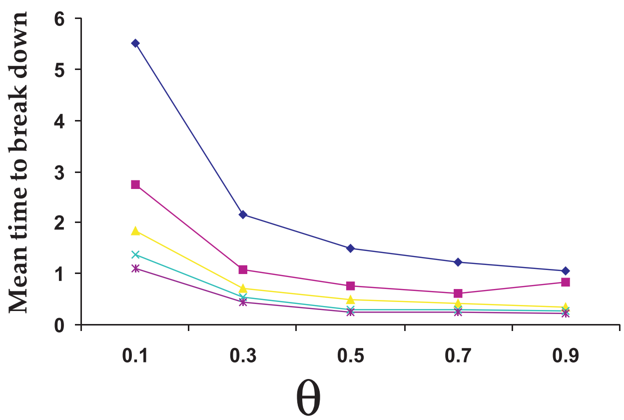

Figure 1. Behaviour of mean

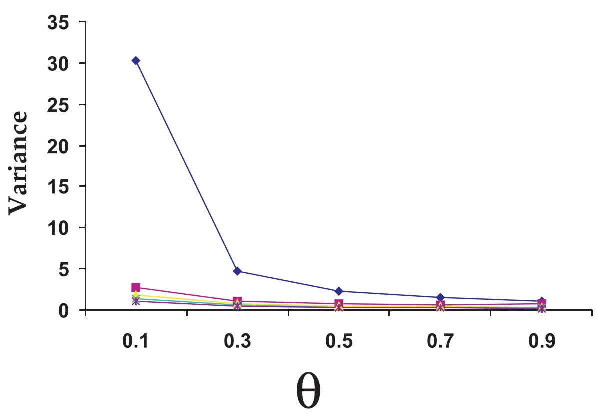

Figure 1. Behaviour of variance

REFERENCES

Baldev R. Sharma 1970 Absenteeism a Search for correlates, *Ind. Jrnl. of Indus. Relations*, 3: 268- 89.

Bhatia, S.K., 1979, How to tackle Absenteeism (*Methodology for systematic Analysis*), *Natl. Labr. Insti. Bulletin,* 5, 7-8, July – Aug., 1979.

Chitrakalarani, T. and Ganesan M.S. 2002, A stochastic model for the study of cumulative Effects of Industrial Accidents, *J. Stoch. and its applns. process*, 5: 53 -56.

Coles M.G., Treble J.G. 1993, *The Price of Worker reliability*. *Econ. Lett.* 44: 34-46.

Dasgupta A. and Pecht M. 1991, *Material Failure mechanisms and Damage*, IEEE Transtn. on Reliability, 40: 531 – 6 .

Desai, K.G. Absenteeism – A problem solving approach, *The Ind. J. Indus. relations,* 3 :268-269.

EnidPerlin. 1977 Eyes without Sight: Education and mill workers in south India 1939-76, *The Ind. Econ. and socl. Hist. Review*, 18,(3 & 4): 263-86.

Esary, J. D, Marshall A W .and Proschan F .1973 .*Shock Models and Wear processes*, *Ann. of Prob.*, 1: 627-49.

Froidevaux P. 1973 Berliet comes to grip with Absenteeism *Euro. Business*, 37: 27-34.

Jensen Soren and McIntosh James. 2006. Absenteeism in the work place: results from Danish sample survey Data. *Emprical Econ.*, 32: 125-139.

Wiess, A. 1985. Absenteeism and wages. *Econ. Lett.*, 19:277-279.