

# Variance of Time to Recruitment for a Two Graded Manpower System with Inter-Decision Times Forms Order Statistics with Independent and Non-Identically Wastages

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**ABSTRACT:** In this paper, an organization subjected to a random exit of personnel due to policy decisions taken by the organization is considered; there is an associated loss of manpower if a person quits the organization. As the exit of personnel is unpredictable, a recruitment policy involving two thresholds, optional and mandatory is suggested to enable the organization to plan its decision on appropriate univariate policy of recruitment. Based on shock model approach, a mathematical model is constructed using an appropriate univariate policy of recruitment. The analytical expressions for mean and variance of time to recruitment is obtained when i) the loss of manpower forms a sequence of independent and non-identically distributed exponential random variables ii) inter-decision times are order statistics iii) the optional and mandatory thresholds having exponential distribution.

**KEYWORDS:** Manpower planning, Shock models, Univariate recruitment policy, Hypo-exponential distribution, Order Statistics

## I. INTRODUCTION

Exit of personnel which is in other words known as wastage is an important aspect in the study of man power planning. Many models have been discussed using different kinds of wastages and different types of distributions. In [5], for a single grade man power system with a mandatory exponential threshold for the loss of man power, the authors have obtained the system performance measures namely mean and variance of the time to recruitment when the inter-decision times form an order statistics. Since the number of exits in every 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 threshold crossing. In [2], for a single grade man power system, the author has introduced the concept of alertness in the recruitment policy which involves two thresholds – one is optional and the other is mandatory and obtained mean and variance of the time to recruitment under different conditions. In [8],[9] and [10], for a two grade man power system involving optional and mandatory thresholds, the authors have obtained mean and variance of time to recruitment according as the thresholds are exponential random variable or geometric random variable and extended exponential random variable when the inter-decision times form an order statistics. In [3], the authors have studied the system characteristics using different univariate policies of recruitment and by assuming different types of thresholds and wastages.

Recently in [6], the authors have obtained mean and variance of time to recruitment for a two graded manpower system with a univariate policy of recruitment involving (i) the loss of manpower and inter-decisions times are independent and non-identically distributed exponential random variables (ii) thresholds optional and mandatory follows exponential random variables. In [7], the authors have obtained mean and variance of time to recruitment for a two graded manpower system with a univariate policy of recruitment involving (i) the loss of man hours are independent

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and non-identically distributed exponential random variables (ii) the inter-decisions times are exchangeable and constantly correlated (iii) thresholds optional and mandatory follows exponential random variables.

The objectives of the present paper is to study the problem of time to recruitment for a two graded manpower systems and to obtain the mean and variance of time to recruitment using CUM univariate recruitment policy for exponential thresholds with loss of manpower having independent and non-identically distributed exponential random variables, inter-decision times having order Statistics. The analytical results are numerically illustrated and the influence of nodal parameters on the mean and variance of time to recruitment is studied.

## II. NOTATIONS

$X_i$  : The loss of manpower due to the  $i^{\text{th}}$  decision epoch  $i=1, 2, 3, \dots$  forming a sequence of independent and non-identically distributed exponential random variables with parameters  $\alpha_i, (\alpha_i > 0)$ .

$G_i(\cdot)$  : The distribution function of  $X_i$

$g_i(\cdot)$  : The probability density function of  $X_i$  with mean  $\frac{1}{\alpha_i} (\alpha_i > 0)$

$S_k$  : Cumulative loss of manpower in the first  $k$ -decisions ( $k=1, 2, \dots$ ), i.e.  $S_k = \sum_{i=1}^k X_i$

$G_k(\cdot)$  : The distribution function of sum of  $k$  independent and non-identically distributed exponential random variables.

$g_k(\cdot)$  : The probability density function of  $S_k$

$$G_k(t) = \sum_{i=1}^k c_i (1 - e^{-\alpha_i t}), \quad g_k(t) = \sum_{i=1}^k c_i \alpha_i e^{-\alpha_i t}$$

$$g_k^*(s) = \sum_{i=1}^k c_i \frac{\alpha_i}{\alpha_i + s} \quad \text{where } c_i = \prod_{\substack{j=1 \\ j \neq i}}^k \frac{\alpha_j}{\alpha_j - \alpha_i}, \quad i = 1, 2, \dots, k$$

$U_k$  : A continuous random variables denoting the inter-decision times between  $(k-1)^{\text{th}}$  &  $k^{\text{th}}$  decision epochs,  $k = 1, 2, 3, \dots$  forms order statistics

$F_k(\cdot)$  : Probability distribution function of  $U_k$ .

$f_k(\cdot)$  : Probability density function of  $U_k$

$U_{(1)}$  : The smallest order Statistic

$f_{u(1)}$  : Probability density function of  $U_{(1)}$

$U_{(m)}$  : The largest order Statistic

$f_{u(m)}$  : Probability density function of  $U_{(m)}$

$Y_1, Y_2$  : The continuous random variables denoting the optional thresholds levels for the grade1 & grade 2 follows exponential distribution with parameters  $\lambda_1, \lambda_2$  respectively.

$Z_1, Z_2$  : The continuous random variables denoting the mandatory thresholds levels for the grade1 & grade2 follows exponential distribution with parameters  $\mu_1, \mu_2$  respectively.

$W$  : The continuous random variable denoting the time to recruitment in the organization.

$p$  : The probability that the organization is not going for recruitment whenever the total loss of manpower crosses the optional threshold  $Y$ .

$V_k(t)$  : The probability that exactly  $k$ -decisions are taken in  $[0, t)$

$L(\cdot)$  : Distribution function of  $W$

$l(\cdot)$  : The probability density function of  $W$

$l^*(\cdot)$  : The Laplace transform of  $l(\cdot)$

$E(W)$  : The expected time to recruitment

$V(W)$  : The variance of the time to recruitment

**CUM policy : Recruitment is done whenever the cumulative loss of manpower crosses the mandatory threshold. The organization may or may not go for recruitment if the cumulative loss of**

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manpower crosses the optional threshold.

### III. MAIN RESULTS

The survival function of W is given by

$$P(W > t) = \sum_{k=0}^{\infty} V_k(t) P(S_k < Y) + \sum_{k=0}^{\infty} V_k(t) P(S_k \geq Y) P(S_k < Z) p \quad (1)$$

For maximum case

$$P(S_k < Y) = \int_0^{\infty} P(S_k < Y | S_k = x) g_k(x) dx$$

$$= g_k^*(\lambda_1) + g_k^*(\lambda_2) - g_k^*(\lambda_1 + \lambda_2) \quad (2)$$

$$P(S_k < Y) = D_1 + D_2 - D_3 \quad (3)$$

$$\text{Similarly } P(S_k < Z) = g_k^*(\mu_1) + g_k^*(\mu_2) - g_k^*(\mu_1 + \mu_2) \quad (4)$$

$$P(S_k < Y) = D_4 + D_5 - D_6 \quad (5)$$

$$\text{Where } D_1 = g_k^*(\lambda_1) \quad D_2 = g_k^*(\lambda_2) \quad D_3 = g_k^*(\lambda_1 + \lambda_2)$$

$$D_4 = g_k^*(\mu_1) \quad D_5 = g_k^*(\mu_2) \quad D_6 = g_k^*(\mu_1 + \mu_2)$$

Sub (3) & (5) in (1), we get,

$$P(W > t) = \sum_{k=0}^{\infty} V_k(t) \{ (D_1 + D_2 - D_3) (1 - p(D_4 + D_5 - D_6)) + p(D_4 + D_5 - D_6) \} \quad (6)$$

$$P(W > t) = \sum_{k=0}^{\infty} V_k(t) (B_k (1 - pC_k) + pC_k) \quad (7)$$

$$P(W > t) = \sum_{k=0}^{\infty} V_k(t) A_k \text{ where } A_k = B_k (1 - pC_k) + pC_k \quad (8)$$

Where  $B_k = D_1 + D_2 - D_3$  and  $C_k = D_4 + D_5 - D_6$

From renewal theory and using  $L(t) = 1 - P(W > t)$ ,  $\frac{d}{ds} L(t) = l(t)$ , Laplace transform of  $l(t) = l^*(s)$ , we get

$$V_k(t) = F_k(t) - F_{k+1}(t) \text{ \& } F_0(t) = 1$$

$$l^*(s) = \sum_{k=0}^{\infty} f_{k+1}^*(s) A_k - \sum_{k=0}^{\infty} f_k^*(s) A_k \quad (9)$$

$$\text{Where } A_k = [g_k^*(\lambda_1) + g_k^*(\lambda_2) - g_k^*(\lambda_1 + \lambda_2)] [1 - p(g_k^*(\mu_1) + g_k^*(\mu_2) - g_k^*(\mu_1 + \mu_2))] + p[g_k^*(\mu_1) + g_k^*(\mu_2) - g_k^*(\mu_1 + \mu_2)]$$

Let  $U_1, U_2, U_3, U_4, \dots, U_m$  be arranged in an increasing order so that we have sequence  $U_{(1)}, U_{(2)}, U_{(3)}, U_{(4)}, \dots, U_{(m)}$ .  $U_{(r)}$  is the  $r^{\text{th}}$  order statistics  $r=1,2,3,\dots,m$ . The random variables  $U_{(1)}, U_{(2)}, U_{(3)}, U_{(4)}, \dots, U_{(m)}$  are not independent.

For  $r=1,2,3,\dots,m$ , the probability density function of  $U_{(r)}$  is given by

$$f_{u(r)}(t) = r(mC_r)(F(t))^{r-1} f(t)(1 - F(t))^{m-r}, \quad r=1,2,3,\dots,m, \text{ Where } f(t) = F'(t) \quad (10)$$

According as probability density function of inter-decision times in (9) if  $f_{u(1)}(t)$  (or)  $f_{u(m)}(t)$  when the cumulative distribution  $F(t)$  of  $U_i, i=1,2,3,\dots$  is given by

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$$F(t) = 1 - e^{-\beta t}, \quad f(t) = \beta e^{-\beta t} \tag{11}$$

When the probability density function of inter-decision times are that of the first order statistics.

Suppose  $f(t) = f_{u(1)}(t)$ , From the Equation (10), we get

$$f_{u(1)}(t) = m\beta e^{-m\beta t}, \tag{12}$$

$$f_{u(1)}^*(s) = \frac{m\beta}{m\beta + s} \tag{13}$$

From the equation (9), we get

$$l^*(s) = \sum_{k=0}^{\infty} (f^*(s))^{k+1} A_k - \sum_{k=0}^{\infty} (f^*(s))^k A_k$$

$$l^*(s) = [f^*(s) - 1] f^*(s) \sum_{k=1}^{\infty} (f^*(s))^{k-1} A_k \tag{14}$$

It is known that

$$E(W) = - \left[ \frac{d}{ds} l^*(s) \right]_{s=0} \tag{15}$$

$$E(W^2) = \left[ \frac{d^2}{ds^2} l^*(s) \right]_{s=0} \tag{16}$$

$$\text{Var}(W) = E(W^2) - (E(W))^2 \tag{17}$$

**Case (i):**

Suppose  $f(t) = f_{u(1)}(t)$

$$f^*(s) = f_{u(1)}^*(s) = \frac{m\beta}{m\beta + s} \tag{18}$$

Substitute the equation (18) in equation (14), we get

$$l^*(s) = [f_{u(1)}^*(s) - 1] f_{u(1)}^*(s) \sum_{k=1}^{\infty} (f_{u(1)}^*(s))^{k-1} A_k$$

$$l^*(s) = \left[ \frac{-s}{m\beta + s} \right] \sum_{k=1}^{\infty} \left[ \frac{(m\beta)^k}{(m\beta + s)^k} \right] A_k \tag{19}$$

$$\frac{d}{ds} l^*(s) = \left[ \frac{-s}{m\beta + s} \right] \left\{ \sum_{k=1}^{\infty} (m\beta)^k \left( \frac{-k}{(m\beta + s)^{k+1}} \right) A_k \right\} + \sum_{k=1}^{\infty} \left[ \frac{(m\beta)^k}{(m\beta + s)^k} \right] A_k \left( \frac{-(m\beta + s) + s}{(m\beta + s)^2} \right)$$

$$\left[ \frac{d}{ds} l^*(s) \right]_{s=0} = - \sum_{k=1}^{\infty} \frac{A_k}{m\beta}$$

$$E(W) = - \left[ \frac{d}{ds} l^*(s) \right]_{s=0} = \sum_{k=1}^{\infty} \frac{A_k}{m\beta} \tag{20}$$

$$\frac{d^2}{ds^2} l^*(s) = \left\{ \left( \frac{-s}{m\beta + s} \right) \left( \sum_{k=1}^{\infty} -k(m\beta)^k (-1)(m\beta + s)^{-2} A_k \right) + \left( \sum_{k=1}^{\infty} (m\beta)^k \left( \frac{-k}{(m\beta + s)^{k+1}} \right) A_k \right) \left( \frac{-(m\beta)}{(m\beta + s)^2} \right) \right\} \\ + \sum_{k=1}^{\infty} \left[ \frac{(k+2)(m\beta)^{k+1}}{(m\beta + s)^{k+3}} \right] A_k$$

$$\left[ \frac{d^2}{ds^2} l^*(s) \right]_{s=0} = \sum_{k=1}^{\infty} \frac{k}{(m\beta)^2} A_k + \sum_{k=1}^{\infty} \left[ \frac{(k+2)}{(m\beta)^2} \right] A_k$$

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$$E(W^2) = \frac{2}{(m\beta)^2} \sum_{k=1}^{\infty} (k+1)A_k \quad (21)$$

Using the equations (21), (20) in (17), we get the variance of time to recruitment for first order.

**Case (ii):**

Suppose  $f(t) = f_{u(m)}(t)$

From the equation (10), we get  $f_{u(m)}(t) = m(F(t))^{m-1} f(t)$  (22)

By using the fourier Transforms, we get

$$f_{u(m)}^*(s) = \int_0^{\infty} m e^{-st} \beta e^{-\beta t} (1 - e^{-\beta t})^{m-1} dt$$

$$f_{u(m)}^*(s) = m\beta \left(\frac{s}{\beta} + 1, m\right)$$

$$f_{u(m)}^*(s) = \frac{m! \beta^m}{(s+\beta)(s+2\beta)(s+3\beta)\dots(s+m\beta)} \quad (23)$$

Since  $f^*(s) = f_{u(m)}^*(s)$ , from the equations (14) and (22), we get

$$l^*(s) = [f_{u(m)}^*(s) - 1] f_{u(m)}^*(s) \sum_{k=1}^{\infty} (f_{u(m)}^*(s))^{k-1} A_k$$

$$l^*(s) = \left[\frac{m! \beta^m}{B} - 1\right] \left[\frac{m! \beta^m}{B}\right] \sum_{k=1}^{\infty} \left[\frac{m! \beta^m}{B}\right]^{k-1} A_k \quad (24)$$

Where  $B = (s + \beta)(s + 2\beta)(s + 3\beta) \dots (s + m\beta)$

$$l^*(s) = \left(\frac{m! \beta^m}{B} - 1\right) \sum_{k=1}^{\infty} \left[\frac{m! \beta^m}{B}\right]^k A_k \quad (25)$$

$$[B]_{s=0} = \beta \cdot 2\beta \cdot 3\beta \dots m\beta = m! \beta^m$$

$$[B^1(s)]_{s=0} = m! \beta^{m-1} \sum_{n=1}^m \frac{1}{n}$$

$$[B^{11}(s)]_{s=0} = m! \beta^{m-2} \left\{ \left[ \sum_{n=1}^m \frac{1}{n} \right]^2 - \left[ \sum_{n=1}^m \frac{1}{n^2} \right] \right\}$$

$$\frac{d}{ds} l^*(s) = \left(1 - \frac{m! \beta^m}{B}\right) \left( \sum_{k=1}^{\infty} k (m! \beta^m)^k \frac{B^1}{B^{k+1}} A_k \right) - \left(\frac{m! \beta^m B^1}{B^2}\right) \left( \sum_{k=1}^{\infty} \left[\frac{m! \beta^m}{B}\right]^k A_k \right) \quad (26)$$

$$\left(\frac{d}{ds} l^*(s)\right)_{s=0} = \frac{- \sum_{n=1}^m \frac{1}{n}}{\beta} \sum_{k=1}^{\infty} A_k \quad (27)$$

From the equations (15) and (16), we get  $E(W) = \frac{\sum_{n=1}^m \frac{1}{n}}{\beta} \sum_{k=1}^{\infty} A_k$  (28)

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$$\begin{aligned}
 \left[\frac{d^2}{ds^2} t^*(s)\right]_{s=0} &= \left(\sum_{n=1}^m \frac{1}{n}\right)^2 \left[ \sum_{k=1}^{\infty} \frac{k}{\beta^2} + \frac{(k+1)}{\beta^2} \right] A_k + \frac{\sum_{k=1}^{\infty} \left(\sum_{n=1}^m \frac{1}{n^2}\right) A_k}{\beta^2} \\
 E(W^2) &= \left(\sum_{n=1}^m \frac{1}{n}\right)^2 \left[ \sum_{k=1}^{\infty} \frac{2k+1}{\beta^2} \right] A_k + \frac{\sum_{k=1}^{\infty} \left(\sum_{n=1}^m \frac{1}{n^2}\right) A_k}{\beta^2} \tag{29}
 \end{aligned}$$

Using the equations (28), (29) in (17), we get the variance of the time to recruitment for  $n^{\text{th}}$  order statistics.

## IV. NUMERICAL ILLUSTRATIONS

The analytical expressions for the performance measures namely mean and variance of the time to recruitment are analyzed numerically for case (iii) by varying a parameter at a time and keeping others parameters fixed. The effect of nodal parameters of loss of man power ( $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ ) and inter-decision time  $\beta$ ,  $m$  the number of decision epochs in  $(0, t]$  and  $p$  on the performance measures are shown in the following tables.

Case (i) :

**Table 1**

The parameters of loss of man-hours ( $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ ) and  $p$  are fixed. The parameter of inter-decision time  $\beta$  and  $m$  the number of decision epochs in  $(0, t]$  are vary.

$\alpha_1 = 0.001, \alpha_2 = 0.002, \alpha_3 = 0.003, \alpha_4 = 0.004, \alpha_5 = 0.005, p = 0.05,$   
 $\lambda_1 = 0.01, \lambda_2 = 0.013, \mu_1 = 0.02, \mu_2 = 0.025, \beta = 0.6$

$m / \beta$		0.6	0.62	0.64	0.66	0.68
1	E(W)	0.2532	0.2450	0.2373	0.2301	0.2234
	V(W)	1.8314	1.7151	1.6096	1.5135	1.4258
2	E(W)	0.1266	0.1225	0.1187	0.1151	0.1117
	V(W)	0.4578	0.4238	0.4024	0.3784	0.3565
3	E(W)	0.0844	0.0817	0.0791	0.0767	0.0745
	V(W)	0.2035	0.1906	0.1788	0.1682	0.1584
4	E(W)	0.0633	0.0612	0.0593	0.0575	0.0558
	V(W)	0.1145	0.1072	0.1006	0.0946	0.0891
5	E(W)	0.0506	0.0490	0.0475	0.0460	0.0447
	V(W)	0.0733	0.0686	0.0644	0.0605	0.0570

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**Table 2**

The parameter of inter-decision time  $\beta$ , m the number of decision epochs in (0,t] and p are fixed. The parameters of loss of man-hours are  $(\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5)$  and p vary.

$\beta = 0.6, p = 0.05, m = 1, \lambda_1 = 0.01, \lambda_2 = 0.013, \mu_1 = 0.02, \mu_2 = 0.025$

P	$\alpha_1$	$\alpha_2$	$\alpha_3$	$\alpha_4$	$\alpha_5$	E(W)	V(W)
<b>0.05</b>	0.001	0.002	0.003	0.004	0.005	<b>0.2532</b>	<b>1.8314</b>
<b>0.10</b>	0.001	0.002	0.003	0.004	0.005	<b>0.2585</b>	<b>1.8663</b>
<b>0.15</b>	0.001	0.002	0.003	0.004	0.005	<b>0.2638</b>	<b>1.9012</b>
<b>0.20</b>	0.001	0.002	0.003	0.004	0.005	<b>0.2691</b>	<b>1.9360</b>
<b>0.25</b>	0.001	0.002	0.003	0.004	0.005	<b>0.2744</b>	<b>1.9708</b>
0.05	<b>0.001</b>	0.002	0.003	0.004	0.005	<b>0.2532</b>	<b>1.8314</b>
0.05	<b>0.0013</b>	0.002	0.003	0.004	0.005	<b>0.3198</b>	<b>2.2930</b>
0.05	<b>0.0015</b>	0.002	0.003	0.004	0.005	<b>0.3622</b>	<b>2.5820</b>
0.05	<b>0.0017</b>	0.002	0.003	0.004	0.005	<b>0.4030</b>	<b>2.8570</b>
0.05	<b>0.0019</b>	0.002	0.003	0.004	0.005	<b>0.4424</b>	<b>3.1191</b>
0.05	0.001	<b>0.002</b>	0.003	0.004	0.005	<b>0.2532</b>	<b>1.8314</b>
0.05	0.001	<b>0.0023</b>	0.003	0.004	0.005	<b>0.2590</b>	<b>1.8925</b>
0.05	0.001	<b>0.0025</b>	0.003	0.004	0.005	<b>0.2627</b>	<b>1.9316</b>
0.05	0.001	<b>0.0027</b>	0.003	0.004	0.005	<b>0.2663</b>	<b>1.9695</b>
0.05	0.001	<b>0.0029</b>	0.003	0.004	0.005	<b>0.2697</b>	<b>2.0062</b>
0.05	0.001	0.002	<b>0.003</b>	0.004	0.005	<b>0.2532</b>	<b>1.8314</b>
0.05	0.001	0.002	<b>0.0032</b>	0.004	0.005	<b>0.2537</b>	<b>1.8394</b>
0.05	0.001	0.002	<b>0.0034</b>	0.004	0.005	<b>0.2543</b>	<b>1.8472</b>
0.05	0.001	0.002	<b>0.0036</b>	0.004	0.005	<b>0.2548</b>	<b>1.8547</b>
0.05	0.001	0.002	<b>0.0038</b>	0.004	0.005	<b>0.2554</b>	<b>1.8620</b>
0.05	0.001	0.002	0.003	<b>0.004</b>	0.005	<b>0.2532</b>	<b>1.8314</b>
0.05	0.001	0.002	0.003	<b>0.0043</b>	0.005	<b>0.2533</b>	<b>1.8341</b>
0.05	0.001	0.002	0.003	<b>0.0045</b>	0.005	<b>0.2534</b>	<b>1.8359</b>
0.05	0.001	0.002	0.003	<b>0.0047</b>	0.005	<b>0.2535</b>	<b>1.8376</b>
0.05	0.001	0.002	0.003	<b>0.0049</b>	0.005	<b>0.2536</b>	<b>1.8392</b>
0.05	0.001	0.002	0.003	0.004	<b>0.005</b>	<b>0.2532</b>	<b>1.8314</b>
0.05	0.001	0.002	0.003	0.004	<b>0.050</b>	<b>0.2543</b>	<b>1.8538</b>
0.05	0.001	0.002	0.003	0.004	<b>0.060</b>	<b>0.2544</b>	<b>1.8549</b>
0.05	0.001	0.002	0.003	0.004	<b>0.089</b>	<b>0.2545</b>	<b>1.8568</b>
0.05	0.001	0.002	0.003	0.004	<b>0.101</b>	<b>0.2546</b>	<b>1.8594</b>

Case (ii) :

**Table 1**

The parameters of loss of man-hours  $(\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5)$  and p are fixed. The parameter of inter-decision time  $\beta$  and m the number of decision epochs in (0,t] are vary.

$\alpha_1 = 0.001, \alpha_2 = 0.002, \alpha_3 = 0.003, \alpha_4 = 0.004, \alpha_5 = 0.005, p = 0.05,$   
 $\lambda_1 = 0.01, \lambda_2 = 0.013, \mu_1 = 0.02, \mu_2 = 0.025, \beta = 0.6$

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$m / \beta$		0.6	0.62	0.64	0.66	0.68
1	E(W)	0.2532	0.2450	0.2373	0.2301	0.2234
	V(W)	1.0628	0.9954	0.9341	0.8784	0.8275
2	E(W)	0.3797	0.3675	0.3560	0.3452	0.3351
	V(W)	1.9694	1.8444	1.7309	1.6276	1.5333
3	E(W)	0.4641	0.4492	0.4351	0.4219	0.4095
	V(W)	2.7284	2.5552	2.3980	2.2549	2.1242
4	E(W)	0.5274	0.5104	0.4945	0.4795	0.4654
	V(W)	3.3823	3.1676	2.9727	2.7953	2.6333
5	E(W)	0.5780	0.5594	0.5419	0.5255	0.5100
	V(W)	3.9589	3.7076	3.4795	3.2718	3.0822

**Table 2**

The parameter of inter-decision time  $\beta$ ,  $m$  the number of decision epochs in  $(0,t]$  and  $p$  are fixed. The parameters of loss of man-hours are  $(\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5)$  and  $p$  vary.

$\beta = 0.6, p = 0.05, m = 2, \lambda_1 = 0.01, \lambda_2 = 0.013, \mu_1 = 0.02, \mu_2 = 0.025$

$p$	$\alpha_1$	$\alpha_2$	$\alpha_3$	$\alpha_4$	$\alpha_5$	E(W)	V(W)
0.05	0.001	0.002	0.003	0.004	0.005	0.3797	1.9694
0.10	0.001	0.002	0.003	0.004	0.005	0.3877	2.0416
0.15	0.001	0.002	0.003	0.004	0.005	0.3957	2.1149
0.20	0.001	0.002	0.003	0.004	0.005	0.4036	2.1896
0.25	0.001	0.002	0.003	0.004	0.005	0.4116	2.2655
0.05	0.001	0.002	0.003	0.004	0.005	0.3797	1.9694
0.05	0.0013	0.002	0.003	0.004	0.005	0.4798	2.9679
0.05	0.0015	0.002	0.003	0.004	0.005	0.5433	3.7066
0.05	0.0017	0.002	0.003	0.004	0.005	0.6046	4.4946
0.05	0.0019	0.002	0.003	0.004	0.005	0.6636	5.3250
0.05	0.001	0.002	0.003	0.004	0.005	0.3797	1.9694
0.05	0.001	0.0023	0.003	0.004	0.005	0.3884	2.0483
0.05	0.001	0.0025	0.003	0.004	0.005	0.3940	2.0996
0.05	0.001	0.0027	0.003	0.004	0.005	0.3994	2.1498
0.05	0.001	0.0029	0.003	0.004	0.005	0.4046	2.1991
0.05	0.001	0.002	0.003	0.004	0.005	0.3797	1.9694



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0.05	0.001	0.002	<b>0.0032</b>	0.004	0.005	<b>0.3806</b>	<b>1.9772</b>
0.05	0.001	0.002	<b>0.0034</b>	0.004	0.005	<b>0.3814</b>	<b>1.9847</b>
0.05	0.001	0.002	<b>0.0036</b>	0.004	0.005	<b>0.3822</b>	<b>1.9920</b>
0.05	0.001	0.002	<b>0.0038</b>	0.004	0.005	<b>0.3830</b>	<b>1.9992</b>
0.05	0.001	0.002	0.003	<b>0.004</b>	0.005	<b>0.3797</b>	<b>1.9694</b>
1 <sup>0.05</sup>	0.001	0.002	0.003	<b>0.0043</b>	0.005	<b>0.3800</b>	<b>1.9716</b>
0.05	0.001	0.002	0.003	<b>0.0045</b>	0.005	<b>0.3801</b>	<b>1.9730</b>
0.05	0.001	0.002	0.003	<b>0.0047</b>	0.005	<b>0.3803</b>	<b>1.9743</b>
0.05	0.001	0.002	0.003	<b>0.0049</b>	0.005	<b>0.3804</b>	<b>1.9757</b>
0.05	0.001	0.002	0.003	0.004	<b>0.005</b>	<b>0.3797</b>	<b>1.9694</b>
0.05	0.001	0.002	0.003	0.004	<b>0.050</b>	<b>0.3824</b>	<b>1.9850</b>
0.05	0.001	0.002	0.003	0.004	<b>0.070</b>	<b>0.3816</b>	<b>1.9863</b>
0.05	0.001	0.002	0.003	0.004	<b>0.089</b>	<b>0.3817</b>	<b>1.9871</b>
0.05	0.001	0.002	0.003	0.004	<b>0.205</b>	<b>0.3819</b>	<b>1.9888</b>

## V. CONCLUSION

**Case (i) :** From the tables, we observe the following

From the table 1, (a) The mean and variance of the time to recruitment decrease as the number of decisions  $m$  and inter-decision times  $\beta$  are increases simultaneously.

(b) If  $m$ , the number of decision epochs in  $(0,t]$  increases, while the mean and variance of the time to recruitment decrease .

(c) As  $\beta$ , inter-decision times are increase, the average inter-decision time decreases and hence mean and variance of the time to recruitment decrease.

From the table 2, (a) As loss of man hours are increases, the average loss of man hours decreases and hence the mean and variance of the time to recruitment increases.

(b) As  $p$  alone increases, the mean and variance of the time to recruitment increases.

**Case (ii) :**

From the table 1, (a) The mean and variance of the time to recruitment increase as the number of decisions  $m$  and inter-decision times  $\beta$  are increases simultaneously.

(b) If  $m$ , the number of decision epochs in  $(0,t]$  increases, while the mean and variance of the time to recruitment increase .

(c) As  $\beta$ , inter-decision times are increase, the average inter-decision time decreases and hence mean and variance of the time to recruitment decrease.

From the table 2, (a) As loss of man hours are increases, the average loss of man hours decreases and hence the mean and variance of the time to recruitment increases

(b) As  $p$  alone increases, the mean and variance of the time to recruitment increases.

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