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J. Kalaivani
Department of Statistics,
Annamalai University,
Annamalai Nagar – 608 002,
India.

R. Elangovan
Department of Statistics,
Annamalai University,
Annamalai Nagar – 608 002,
India.

Correspondence:
J. Kalaivani
Department of Statistics,
Annamalai University,
Annamalai Nagar – 608 002,
India.

Estimation of manpower wastage using cox's approach

J. Kalaivani, R. Elangovan

Abstract
The usage of Cox's Regression Model is to Estimate the wastage of the organization. In any organization wastage occurs mainly in two forms voluntary or involuntary wastage. Voluntary wastage may be due to an individual's decision to quit the job or due to voluntary retirement whereas involuntary wastage may happen due to retrenchment, retirement or death of the person etc., In manpower planning, one of the most important variables is completed length of service (CLS) on leaving a job, since it enables us to predict staff turnover. In this paper to analyze and predict the pattern of manpower wastage using Cox's approach to Exponential-Gamma and Exponential- Half Log Logistic distribution. A real software industrial data has been used to validate the above models.

Keywords: Manpower wastage, Complete Length of Service (CLS), Cox's Approach,

1. Introduction
In manpower planning, one of the most important variables is Completed Length of Service (CLS) on leaving a job, since it enables us to predict staff turnover. It is often the case that failure time data is right censored, i.e. for some of the data we know only that failure takes place after a certain time but not exactly when it occurs. In the medical literature this corresponds to there being patients in the sample who are still alive when data collection is terminated, so we know only that their lifetime is greater than a certain value. For such data much work has been done on both non-parametric and parametric estimation of the survivor function. Wastage can be studied on the basis of an individual's exposure in his profession. Several authors including Bartholomew (1982), Bartholomew and Forbes (1979) [1] have studied the concept of wastage and its relation to the Completed Length of Service (CLS). Some interesting results can also seen in Sathiyamoorthi *et al*. (2005), Elangovan *et al*. (2005), Vijayasankar *et al*. (2008), (2008), Susiganeshkumar and Elangovan (2012). This paper is to deal with Cox's partial likelihood using Exponential-Gamma and Exponential-Half Log Logitics distribution have been discussed in real data example is used to illustrate the Cox's approach.

2. Cox's Partial Likelihood
Cox's regression model is a unique approach in which the propensity to leave the job can be estimated in terms of probability. In doing so, the CLS as well as the personal covariates are both combined together. It may be observed that the CLS is a quantitative type whereas the personal covariates are binary numbers taking value 0 and 1. They are used to define the attribute characters which cannot be represented in quantitative terms. For a detailed study refer to Cox (1972) [5]
The Cox's regression model (1975) based on the method of 'Partial likelihood' plays a very important role in analyzing the data in a more realistic way on survival or fertility on any other kind involving population characteristics using Stochastic models. The partial likelihood estimating the parameters by the method of maximum likelihood conjectured that the method would give estimates of $\beta_1, \beta_{2, \ldots,} \beta_p$ which would have otherwise the asymptotic properties of the maximum likelihood estimators. The instantaneous propensity of leaving a

job (or profession) at time t is defined as the conditional probability of leaving a job (or profession) during an infinitesimal interval (t, t + dt) given that the person was in job till the time t. Denoting the hazard rate by h(t), we have

$$h(t)dt = {f(t)dt}\big/{R(t)} \quad \dots (1)$$

where R(t) is the Survival function or the probability of continuing the job at least upto a period t and f(t)dt is the probability of leaving the job between (t, t + dt). It can be shown that

$$R(t) = \exp\left[-\int_0^t h(\tau)d(\tau)\right] \text{ and } f(t) = \frac{d}{dt}(1 - F(t)) = \frac{d}{dt}R(t) \quad \dots (2)$$

The Cox hazard model as indicated by (vide Gill (1984)).

$$h(t) = h_0(t)\exp(\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_k X_k) \quad \dots (3)$$

Where $h_0(t)$ represents the hazard rate or the rate of propensity of leaving at time t purely on the consideration of time or CLS in the profession. $h_0(t)$ is called the base line hazard rate. The probability that the i-th person will leave the job at time t in (0, T) is given by

$$\frac{h_0(t)e^{\beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i}}}{h_0(t)\sum_{i=1}^{n} e^{\beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i}}}, \quad (i = 1, 2, \cdots, n) \quad \dots (4)$$

where $X_{1i} + X_{2i} + X_{3i}$ are the scores of the covariates 1, 2 and 3 respectively of the i-th person. Note that the ratio in eqn. (4) is independent of t, the length of service. If we take the product of all such terms for all the professionals with serial number 1, 2, …, k, we get a simplified form of Cox's partial likelihood given by

$$P_L = \prod_{i=1}^{k} \frac{e^{\beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i}}}{\sum_{i=1}^{k} e^{\beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i}}} \quad \dots (5)$$

Maximizing P_L (or $\log P_L$) with respect to β_1, β_2, and β_3 respectively, we get three estimating equations for estimating β_1, β_2, and β_3 (assuming $e^{\beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i}} \cong (1 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i})$ approximately both in the numerator and denominator of equation (5) as follows:

$$\sum_{i=1}^{k} X_{1i} - k\frac{\sum_{i=1}^{k} X_{1i}(1 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i})}{\sum_{i=1}^{k}(1 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i})} = 0 \quad \dots (6)$$

$$\sum_{i=1}^{k} X_{2i} - k\frac{\sum_{i=1}^{k} X_{2i}(1 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i})}{\sum_{i=1}^{k}(1 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i})} = 0 \quad \dots (7)$$

$$\sum_{i=1}^{k} X_{3i} - k\frac{\sum_{i=1}^{k} X_{3i}(1 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i})}{\sum_{i=1}^{k}(1 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i})} = 0 \quad \dots (8)$$

Having estimated the parameters β_1, β_2, and β_3 relating to the covariates, the parameters affecting the leaving from profession for personal reason or covariates, we estimate the parameter of the CLS corresponding to the base line hazard function. For a detailed study on the subject in this direction, refer to Biswas (1988) [2], Biswas and Adhikari (1992) [4] and Fang and Li (2005).

3. Estimation of the Longevity of Service

Once the parameters viz., time dependent parameters concerning the CLS as well the parameters concerning the personal covariates β_1, β_2, and β_3 are estimated independently, the expected length of service can be obtained by the relationship between survival function R(t) and the expected or average duration of service given by L as

$$E(L) = \int_0^{\infty} R(t)dt = \int_0^{\infty} e^{\int_0^{\infty} -h(T)dT} \quad \dots (9)$$

$$= \int_0^{\infty} e^{-\int_o^t \exp(\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3)h(T)dT} \quad \dots (10)$$

$$\left[\Theta\ R(t) = e^{-\int_0^t h(T)dT} \text{ and } h(t) = h_0(t)\exp(\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3)\right]$$

Finally expected duration of service given by

$$E(L) = \int_0^{\infty} e^{\int_0^t -h(T)dT}$$

The proportion or the percentage of leavers between t and (t + 1) is accordingly given by

$$f(t) = \frac{d}{dt}(1 - R(t)) \text{ or } f(t) \times 100\% \quad \dots (11)$$

For a detailed study refer to Biswas (1996), Cox (1972), Cox (1975), Sathiyamoorthy *et al.* (2006d).

4. The Exponential-Gamma distribution

The Exponential-Gamma Additive failure rate distribution is the additional of hazard function of Exponential model and Gamma model with shape 2 is developed. For a detailed study, refer to B.Srinivasa Rao (2013).

The probability density function is given by

$$f(t) = (\alpha + \beta t)\exp\left\{-\alpha t - \frac{\beta}{2}t^2\right\} \quad \dots (12)$$

where $\beta > 0$ and $\alpha > 0$ are parameters sometimes referred to as the shape and scale parameters of the distribution.

The survivor and hazard functions are respectively,

$$s(t) = \exp\left\{-\alpha t - \frac{\beta t^2}{2}\right\} \quad \dots (13)$$

$$h(t) = (\alpha + \beta t) \quad \dots (14)$$

5. The Exponential- Half Log Logistic distribution

The combination of Exponential and log- logistic failure rate model is considered and named it as exponential Half log-logistic additive failure rate model.(ELLARM).The distribution with p.d.f is.

$$f(t) = \frac{2^{\frac{1}{\sigma}} e^{-\lambda t}}{(1+e^{\sigma t})^{\frac{1}{\sigma}+1}}[\lambda(1+e^{\sigma t}) + e^{\sigma t}]$$

$$t > 0, \lambda, \theta > 0 \quad \dots\dots (15)$$

Where t>0, $\sigma, \lambda > 0$ are parameters. The survivor and hazard functions are respectively,

$$s(t) = 1 - \frac{2^{\frac{1}{\sigma}} e^{-\lambda t}}{(1+e^{\sigma t})^{\frac{1}{\sigma}+1}}, \qquad t > 0, \lambda, \theta > 0 \quad \dots (16)$$

$$h(t) = \lambda + \frac{e^{\sigma t}}{1+e^{\sigma t}}, \qquad t > 0, \lambda, \theta > 0 \quad \dots\dots (17)$$

For a detailed study refer to Rosaiah (2014).

6. Testing the Model

(i) As an Estimator

Let N_{ij}be the number of people starting in year Y_i who are still in service in year Y_j(i = 1, …,n; j = i,…,n). Then N_{ii} people are recruited in year Y_i and N_{in} of these are still in service in year Y_n. Let p_i be the probability of surviving *i* years in the firm, and $\hat{p}_i$ an estimate of p_i obtained using either the Weibull or Extreme value models. Then, since N_{in} ~ Binomial (N_{ii}, p_{n-i}), we have

$$(N_{in} - N_{ii}\hat{p}_{n-i})^2 \Big/ \{N_{ii}\hat{p}_{n-i}(1-\hat{p}_{n-i})\} \sim \chi^2(1)$$

Then, since the behaviour of each year's is independent of other, we have

$$\sum_{i=1}^{n-1} (N_{in} - N_{ii}\hat{p}_{n-i})^2 \Big/ \{N_{ii}\hat{p}_{n-i}(1-\hat{p}_{n-i})\} \sim \chi^2(n-1) \quad \dots (18)$$

This statistic can therefore be used to test the set $\{\hat{p}_j\}$ as an estimator for $\{p_j\}$ provided that the leaving probabilities are independent of time. The test statistic is suggested by McClean (1975) [9].

(ii) As a Predictor

The model can also be tested as a predictor if the number of survivors from the last year, Y_n, used in estimation, to the following year, Y_{n+1}, is known. Thus if N_{in} is the number of people recruited in year Y_i who are in service in year Y_n and M_i is the observed number of these who survive one more year to Y_{n+1}, them M_i has a binomial distribution B(N_{in}, r_i) where $r_i = p_{n-i+1} / P_{n-i}$. Therefore we have

$$(M_i - N_{in} r_i)^2 \Big/ \{N_{in} r_i (1-r_i)\} \sim \chi^2(1)$$

and since the N_{in} are survivors from different entry and therefore independent it follows that

$$\sum_{i=1}^{k} (M_i - N_{in} r_i)^2 \Big/ \{N_{in} r_i (1-r_i)\} \sim \chi^2(k) \quad \dots (19)$$

and this statistic can be used as a measure of the accuracy of prediction of the model. Obviously this is not just restricted to predictions for one year ahead and a similar statistic can be determined for testing predictions for any number of years ahead. The test statistic is suggested by McClean (1975) [9].

7. Results

(i) CLS as Exponential-Gamma and Exponential-Half Log Logistic distribution

The χ^2 values for testing estimation as in eqn. (18) for Exponential-Gamma and Exponential-Log Logistic distribution given in table 1 for the selected to Software companies of Tamilnadu.

Table 1: χ^2 values for testing Estimation as in equ. (18)

Company	Exponential-Gamma		Exponential- Half Log Logistic	
	χ^2	d.f.	χ^2	d.f.
1	19.4362	7	22.9272	9
2	16.1313	6	16.1623	5
3	14.4374	5	27.6143	6
4	10.7315	3	27.5484	5
5	8.2623	4	18.9055	4
6	6.8314	3	16.0286	3
7	5.7175	2	14.7357	2
8	3.7912	4	14.0382	3
9	1.0532	3	12.8391	4
10	3.7312	2	5.4304	3

The χ^2 values for testing the prediction as in eqn. (19) for the Exponential-Gamma and Exponential- Half Log Logistic distribution are given in table 2 for the selected Software 10 companies of Tamil Nadu.

Table 2: χ^2 values for testing Prediction as in equ. (19)

Company	Exponential-Gamma		Exponential log Logistic	
	χ^2	d.f.	χ^2	d.f.
1	10.1412	9	15.1411	8
2	7.3522	5	12.3522	6
3	5.4533	7	15.5513	9
4	4.4321	13	14.5314	7
5	3.4542	10	13.4582	7
6	17.4451	11	19.4563	10
7	19.4622	5	21.4724	7
8	12.4733	7	15.4845	8
9	15.4744	12	19.4326	10
10	6.4521	8	10.8474	6

(ii) Cox's Approach

Case (i): CLS as Exponential-Gamma distribution

The propensity to leave the job based on three personal covariates collected from the data is given in table 4.

Table 3: Data set with three Personal Covariates

Period in year	No. of persons left	Covariate
2008-09	25	(1,1,,1) (1,0,1) (0,0,1) (0,0,0) (1,1,0) (1,1,0) (1,1,1) (1,0,0) (0,1,1) (0,0,1) (0,0,0) (1,1,1) (0,1,0) (0,0,0) (0,0,1) (0,0,0) (1,0,0) (0,1,0) (0,0,0) (0,0,0) (0,1,1) (1,1,0) (0,1,1) (0,0,0) (0,0,0)
2009-10	36	(0,0,0) (0,1,0) (0,0,0) (1,0,0) (1,0,0) (0,0,0) (0,0,0) (0,0,0) (1,1,0) (1,1,1) (0,0,0) (0,0,0) (1,0,0) (0,0,0) (0,0,0) (1,1,0) (1,1,1) (0,0,0) (0,0,0) (0,0,0) (1,0,0) (1,0,0) (1,1,0) (1,1,0) (1,0,0) (0,0,0) (0,0,0) (0,0,0) (0,1,0) (1,1,0) (1,1,1) (1,0,0) (1,1,0) (0,0,0) (0,0,0) (0,1,0)
2010-11	79	(1,1,1) (1,0,0) (1,0,1) (1,1,1) (1,1,1,) (1,0,1) (1,0,0) (1,0,0) (1,0,0) (0,0,0) (1,0,1) (1,1,0) (1,0,0) (1,0,1) (1,0,0) (1,1,0) (0,1,0) (1,0,0) (0,0,0) (1,0,0) (1,0,1) (1,1,1) (0,0,0) (0,0,0) (0,1,0) (1,0,0) (1,1,0) (1,0,1) (1,1,1) (1,1,0) (1,1,1) (1,0,0) (0,0,0) (0,0,0) (0,0,1) (0,1,1) (1,1,1) (1,0,0) (1,1,0) (1,0,0) (0,0,0) (0,0,0) (0,0,1) (1,0,1) (1,1,0) (1,0,0) (1,0,0) (1,0,1) (1,0,0) (1,0,0) (1,1,0) (1,0,0) (0,0,0) (0,1,1) (1,1,0) (1,0,0) (1,0,0) (1,1,0) (1,0,1) (0,1,0) (1,0,1) (1,1,1) (1,0,0) (1,1,1) (1,0,1) (1,0,1) (1,1,0) (1,0,0) (0,1,0) (1,0,0) (1,0,0) (1,0,1) (1,1,0) (1,1,1) (0,0,0) (1,0,1) (1,1,1) (1,1,0) (0,0,1)
2011-12	43	(0,0,0) (0,0,1) (0,0,0) (1,0,0) (0,1,0) (0,0,0) (0,0,0) (0,1,1) (1,1,0) (0,0,0) (0,0,0) (0,1,0) (1,0,1) (0,1,0) (0,0,1) (0,1,1) (1,0,0) (1,1,0) (0,0,0) (0,1,0) (0,1,1) (0,0,0) (0,1,1) (0,1,1) (1,1,0) (0,0,1) (0,0,0) (0,1,0) (0,1,0) (1,0,1) (0,0,0) (0,0,1) (1,0,0) (0,1,0) (0,0,0) (0,1,1) (1,1,0) (0,0,0) (0,0,0) (0,1,0) (1,0,1) (0,1,0) (0,0,1)
2012-13	18	(0,1,1) (1,1,0) (0,0,1) (0,0,0) (0,1,0) (1,0,0) (1,0,1) (0,0,0) (0,0,1) (1,0,0) (0,1,0) (0,0,0) (0,1,1) (0,1,0) (0,0,0) (0,1,0) (0,0,1) (0,1,0)
58 persons who did not have up to 6 years of service		(0,0,0) (0,0,1) (0,0,0) (1,0,0) (0,1,0) (0,0,0) (0,0,0) (0,1,1) (1,1,0) (0,0,0) (0,1,0) (1,0,1) (0,1,0) (0,0,1) (0,1,1) (1,0,0) (0,1,0) (0,0,0) (0,1,0) (0,0,1) (0,1,0) (0,0,1) (1,0,0) (0,1,0) (0,0,0) (0,1,1) (0,0,0) (1,0,1) (0,1,1) (1,1,0) (0,0,0) (0,1,0) (0,1,0) (1,0,1) (0,0,0) (0,0,1) (1,0,0) (0,1,0) (0,0,0) (0,0,1) (1,1,0) (0,0,0) (0,0,0) (0,1,0) (0,0,1) (0,1,1) (1,0,0) (1,1,0) (1,0,0) (0,1,0) (1,0,0) (0,0,0) (1,0,0) (1,1,0) (0,1,0) (0,0,1) (0,0,0) (0,1,0)

$$X_1 = \begin{cases} 1, & \text{if travel time is tedius} \\ 0, & \text{otherwise} \end{cases}$$

$$X_2 = \begin{cases} 1, & \text{if facilities of children's education} \\ 0, & \text{otherwise} \end{cases}$$

$$X_3 = \begin{cases} 1, & \text{if quality of life is satisfactory} \\ 0, & \text{otherwise} \end{cases}$$

The hazard rates for the Exponential-Gamma distribution are given in table 5.

Table 5: Hazard rate for the Exponential-Gamma distribution

T	1	2	3	4	5	6
$h_0(t)$	0.8299	0.5909	0.3617	0.2983	0.1322	0.1064

Using the above data set, the parameter of the Exponential-Gamma distribution given in eqn. (12), are estimated by using the Newton-Raphson method with the Statistical Analysis and System (SAS) package, $\hat{\alpha} = 0.1276, \hat{\beta} = 0.2341$. The parameters are given in eqn. (6), eqn. (7) and eqn. (8) relating to the covariates are estimated as $\hat{\beta}_1$=0.6348, $\hat{\beta}_2$=0.1289, $\hat{\beta}_3$= 3.1846.The probability of leaving the job upto 6 years of service, given the personal covariates are given in the following table 6, table 7as per the above estimates.

Table 6: Probability of Leaving a Job within 6 Years of Service

Personal Covariate	Up to 1 Yr	Between 1 -2 Yrs	Between 2 – 3 Yrs	Between 3 – 4 Yrs	Between 4 – 5 Yrs	Between 5 – 6 Yrs
(1,1,1)	1.0000	1.0000	0.8177	1.0000	1.0000	1.0000
(1,1,0)	0.8177	0.8177	1.0000	1.0000	1.0000	0.8177
(1,0,1)	1.0000	0.2829	0.3141	0.4072	0.5635	0.6822
(0,0,1)	0.7418	1.0000	1.0000	1.0000	1.0000	0.8177
(0,1,1)	0.7613	0.8166	1.0000	0.8177	1.0000	1.0000
(0,1,0)	0.2702	0.4745	0.5152	0.5163	0.7173	0.8177
(1,0,0)	0.1021	0.3724	0.4042	0.6119	0.8176	0.8151
(0,0,0)	0.1042	0.1829	0.3433	0.4725	1.0000	0.6628

Table 7: Probability of Leaving the Job between a Fixed Period of Time

Personal Covariate	$\hat{\beta}_1$ **=0.6348,** $\hat{\beta}_2$ **=0.1289,** $\hat{\beta}_3$ **= 3.1846.**						
	Up to 1 Yr	**Between 1 -2 Yrs**	**Between 2 – 3 Yrs**	**Between 3 – 4 Yrs**	**Between 4 – 5 Yrs**	**Between 5 – 6 Yrs**	**Total**
(1,1,1)	1.0000	-	-	-	-	-	1.0000
(1,1,0)	0.2312	-	-	0.7644	-	-	0.9956
(1,0,1)	0.1229	0.1243	-	0.2123	-	0.4512	0.9107
(0,0,1)	0.7454	0.1968	-	-	-	-	0.9422
(0,1,1)	0.8121	-	0.1385	-	-	-	0.9506
(0,1,0)	0.2325	0.1268	0.3175	0.2986	-	-	0.9754
(1,0,0)	0.6121	0.1125	0.0065	0.0231	0.0342	0.1276	0.9161
(0,0,0)	0.1895	0.2699	0.3256	0.0678	0.0981	0.0491	1.0000

Case (ii): CLS as Exponential- Half Log Logistic distribution

For the CLS distributed as Exponential-Half Log Logistic distribution given in eqn (15), are estimated by using the Newton-Raphson method with the Statistical Analysis and System (SAS) package, $\sigma = 2.0124,\ \lambda = 0.3140$. The hazard rate for the Exponential –Half Log Logistic distribution are given in table 8.

Table 8: Hazard rate for the Exponential-Half Log Logistic distribution

T	1	2	3	4	5	6
$h_0(t)$	0.1718	0.2272	0.2106	0.3976	0.5260	0.6958

After the estimating the parameters are given in eqn. (6), eqn. (7) and eqn. (8) relating to the covariates are estimated as $\hat{\beta}_1$=0.5387, $\hat{\beta}_2$=0.2135, $\hat{\beta}_3$= 2.8162. The probability of leaving the job upto 6 years of service, given the personal covariates are (1,1,1), (1,1,0), (1,0,1), (0,0,1), (0,1,1), (0,1,0), (1,0,0), (0,0,0) given in the following table 9, table 10 as per the above estimates.

Table 9: Probability of Leaving a Job within 6 Years of Service

Personal Covariate	**Up to 1 Yr**	**Between 1 -2 Yrs**	**Between 2 – 3 Yrs**	**Between 3 – 4 Yrs**	**Between 4 – 5 Yrs**	**Between 5 – 6 Yrs**
(1,1,1)	0.9577	1.0000	0.9677	1.0000	1.0000	1.0000
(1,1,0)	1.0000	1.0000	0.0641	0.1572	0.3135	0.4322
(1,0,1)	0.4918	0.2347	0.7354	0.5677	0.5677	0.5677
(0,0,1)	0.5113	0.5666	1.0000	1.0000	1.0000	1.0000
(0,1,1)	0.4202	0.5245	0.5652	0.5663	0.5673	0.5677
(0,1,0)	0.3521	0.42245	0.5542	0.5619	0.7676	0.8677
(1,0,0)	0.2349	0.5431	0.5933	0.6225	0.7526	0.8128
(0,0,0)	0.7568	0.7768	0.4468	0.1768	0.3768	1.0000

Table 10: Probability of Leaving the Job between a Fixed Period of time

Personal Covariate	$\hat{\beta}_1 = 0.5387,\ \hat{\beta}_2 = 0.2135,\ \hat{\beta}_3 = 2.8162$						
	Up to 1 Yr	**Between 1 -2 Yrs**	**Between 2 – 3 Yrs**	**Between 3 – 4 Yrs**	**Between 4 – 5 Yrs**	**Between 5 – 6 Yrs**	**Total**
(1,1,1)	1.0000	-	-	-	-	-	1.0000
(1,1,0)	0.5434	0.2122	-	-	-	-	0.7556
(1,0,1)	0.2334	0.0142	0.3235	0.1622	0.0175	0.2412	0.9921
(0,0,1)	0.5654	0.4346	-	-	-	-	1.0000
(0,1,1)	0.2155	-	0.1742	0.0247	0.0966	0.3569	0.8679
(0,1,0)	0.1435	0.2345	0.3678	0.0473	0.1968	0.0120	0.9708
(1,0,0)	0.6535	0.1353	-	-	0.0324	0.1324	0.9536
(0,0,0)	0.2273	0.3674	-	0.0242	0.1968	0.0042	0.8241

8. Conclusion

The results from table 1 and table 2 shows that the Exponential-Gamma distribution is a better estimator of leaving pattern than the Exponential-Half log logistic distribution. The chi-square value showed that Exponential-Half log logistic distribution could be used as a predictor for the company considered with a reasonable degree of accuracy.

In the case of Cox's approach, the CLS distribution as Exponential-Gamma distribution the probability of leaving the job is a sure event in the case of the category of workers (1,1,1). In the case of the categories (1,1,0), (0,1,0), (0,0,1) and (1,0,0) of persons, the probabilities are low but in all the cases the probabilities increase with the increase in the number of years of service. It is also seen that the category of workers under (0,1,1) have less probability of leaving in successive years but however the probabilities increase with the passage of time.

It is interesting to note that in both the CLS distributions, namely Exponential-Gamma distribution and Exponential Half Log logistic distributions, the probabilities are very low initially and approach unity as the years pass by for the group with covariates (1,0,1) and (1,0,0). It is quite interesting to observe that, for the category of persons with personal covariates as (1,1,1) the propensity to leave the job is very high throughout with the passage of time or CLS. This implies that the travel time is tedious, the facilities of children education are satisfactory and the quality of life is not satisfactory is quite justified. Considering the combination of the personal covariates as (0,1,0) and (0,0,1) the probabilities are very low initially and slowly approach unity with the passage of time. From this one can understand that if a person's travel time is not tedious, the facilities of children education are not satisfactory and the quality of life is not at all satisfactory, the propensity to leave the job is very much less initially but increases as the years pass by. Similar are the interpretations for all the combinations of personal covariates, the probability values depict the realities existing in practical life situations. The Exponential-Gamma distribution is better than the Exponential-Half Log logistic distribution particularly in estimation. However, this is not true in all cases and when predictions are being made for each company then they should examine to see which model is most appropriate.

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