Engineers' Voluntary Turnover: Application of Survival Analysis

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Using a sample of 2141 engineers who were recruited in a large Indian public-sector corporation over 13 years from the year 2000 to 2012, we applied survival analysis to identify the drivers of turnover. In addition to demographic variables and employee performance, we investigated the role of two new variables viz. location match and college ranking. We found that engineers were more likely to leave early if they were younger, unmarried, poor performers, posted in a different region from their home region, and from a premium college.

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Introduction

Since the economic liberalization of the 1990s, there has been a flood of foreign direct investment by multinational corporations setting up and expanding their Indian operations (Holtbrugge, Friedmann & Puck, 2010). Indian companies too have responded to the liberal regime by expanding their businesses and their product range. Hence, in the last twenty years, there has been the creation of numerous opportunities for Indian engineers and managers. This has led to very high attrition rates in most Indian organizations (Gulati & Krishna, 2011; Nancheria, 2009). High attrition (employee-initiated separation) rate has implications for costs (or hiring and training), loss of organizational learning, and customer satisfaction (Koys, 2001). While most companies strive to limit their attrition it is also recognized that some amount of attrition may be necessary for the organization to enable churn in the talent and to bring in newer ideas (Kulshreshtha & Krishna Kumar, 2005).

Employee Turnover

Turnover research is often limited to studying job attitudes and their impact on turnover intention (Chen et al, 2011; Krishnan & Singh, 2010; Lai & Kapstad, 2009; Tett & Mayer, 1993); however, there are some studies, which have also looked at the impact of job attitudes on turnover (Cohen, 1993). In this paper, we investigate the causes of voluntary turnover for engineers in a large public sector corporation. The category of Indian engineers is a class worthy of study because of their pervasiveness in Indian organizations both public and private. This is evidenced by the fact that there have been many studies dedicated to Indian engineers (e.g., Das, 1998; Parikh & Sukhatame, 2004; Sarveswara Rao, 1972; Shanthamani, 1977). Since this study was based on archival data from company records, we were limited by those variables, which were available from the company's database. In addition to demographic variables such as age, gender, and social category, we studied the effect of location match, employee performance, and college ranking.

Demographic Variables

A meta-analysis of turnover has shown that gender and race have no impact on turnover (Griffeth, Hom & Gaertner, 2000). However, we have reason to believe that women engineers' experience of the workplace is quite different from that of males. For example, Parikh & Sukhatme (2004) have identified several issues faced by women engineers in India right across their career. Similarly, Das (1998) in a study of engineers working for two Indian public sector undertakings found that women were paid ten percent less than men of equivalent qualifications and work experience were. A study of on-the-job search in urban India found that younger workers and married workers are more likely to engage in on-the-job search (Banerjee & Bucci, 1995). Hence, keeping in mind the Indian social structure and the high prevalence of patriarchy and caste related issues; we have included age, gender, and marital status as predictors of employee turnover.

In a collectivistic culture like India, interpersonal obligations to family members and social ties with one's community are an important consideration in evaluating one's employment. Because of this, mobility of executives is limited in India and employees prefer employment opportunities at or near their hometown. Hence, we included a variable to measure the extent to which an individual's posting is close to his or her hometown as a predictor of tenure.

Employee Performance

Turnover functionality is dependent on the kind of employees who are leaving the organization.

It has been widely recognized that not all employee turnover is the same. Since different employees have different performance, turnover functionality is dependent on the kind of employees who are leaving the organization (Beadles et al, 2000; Sturman et al, 2003). If high performers are leaving the organization, it is a cause for concern; however, if low performers are leaving the organization, it may be a healthy trend. There is some support for the fact that low performers are more likely to leave the organization and this relationship is especially strong when the organization has performance-contingent rewards (Williams & Livingstone, 1994). Since the organization we are studying is a public sector organization and they do not have any form of performance contingent rewards at the level of graduate engineer trainee, it is difficult to predict the relationship between performance and turnover. Hence, employee performance is an important variable as a determinant of turnover.

Since the wave of economic liberalization in the early 1990s, there has been a huge demand for engineering and management talent in India. Responding to this high demand, there have been a large number of private engineering and management colleges, which have sprung up during the last two decades. The newer colleges however have not been able to reach the quality of the established government colleges such as the Indian Institutes of Technology (IITs). The government too has responded to the high demand for engineering talent by launching a number of new IITs in priority zones across the country. However, these colleges too are considered to be in a different league from the established (i.e., older) IITs. This has led to segmentation amongst engineering colleges and consequently among engineers graduating from these colleges. Some companies recognize this distinction in either of the two ways. First, they may recruit exclusively from the premium institutes and second they may provide differential grades, postings, or salaries depending on the prestige of the institute.

Method

We collected data from Bharat Petroleum Corporation Limited (BPCL), which is one of the largest public sector companies in India, ranked 225 amongst the Fortune Global 500 rankings and having a sales turnover of about USD 45 billion. We studied a sample of 2,141 engineers, which consisted of thirteen cohorts of engineers recruited from the year 2000 to 2012. Eighty percent of the engineers were recruited in the company as officer trainees/ management trainees for marketing unit and the rest as per the graduate engineering trainee (GET) scheme for refineries. The break-up of the number of engineers recruited from each batch is given in Table 1.

For each of the engineers we extracted the following data from the company's database: year of joining, engineering specialization, employment status (0=active, 1=separated), class of city for first posting, ethnicity (scheduled caste, scheduled tribe, other backward classes, open category), home location, gender (0=male, 1=female), performance rating, and age. The performance rating was taken for the last three years (wherever available). In addition to these, we derived two measures, which we felt would be relevant as predictors of attri-

Table 1 Characteristics of the Sample (*N* =2141)

	***N* (%) or Mean ± SD**
Event/censoring: Left the organization	654 (30.55%)
Individual details	
Post graduates	194 (9.06%)
Age (on December 2012 or date of leaving, whichever is earlier)	27 ±4.08
Female (vs. male)	172 (8.03%)
Married (vs. not)	672 (31.39%)
Specialization in engineering	
Mechanical engineering	1053 (49.18%)
Chemical engineering	265 (12.38%)
Instrumentation engineering	74 (3.46%)
Electrical, Electronics, or Computer Science Engineering	546 (25.50%)
Year of joining	
2000	84 (3.92%)
2001	64 (2.99%)
2002	40 (1.87%)
2003	83 (3.88%)
2004	132 (6.17%)
2005	152 (7.10%)
2006	241 (11.26%)
2007	306 (14.29%)
2008	187 (8.73%)
2009	132 (6.17%)
2010	239 (11.16%)
2011	274 (12.80%)
2012	207 (9.67%)

tion viz., location match and college ranking.

Location Match

Location match refers to the extent to which the new recruit's posting location matches with his or her home location. This was derived based on the recruits' home location and the city of first posting. This variable had three levels ranging from 1 to 3. In case the individual was placed in a city which was in a completely different region as compared to his or her home city (e.g., a person from Chennai was placed in New Delhi), then the variable was given a value of one. In case the individual was placed in a city which was in a different state but in the same region as his or her home state (e.g., a person from Chennai was placed in Bangalore), then the variable was two. In case the individual was placed in a city which was in the same state as his or her home state (e.g., a person from Chennai was placed in Madurai), then the variable was three.

College Ranking

There were totally 75 unique colleges from which the recruited engineers had graduated. Each of these colleges was classified into five categories by an expert panel consisting of experienced recruiters from the organization. Later during Kaplan-Meier analysis, we found that only the first category of elite colleges significantly differed from the others on the criteria of job tenure. Hence, college ranking was used as a dummy variable with 1 indicating an elite college and 0 indicating all the other colleges.

Employee Performance

Employee performance was taken from the company database. Each year's employee rating was measured as a percentage. For this study, we took data for the last three years (or part of it depending on the year of joining). Since employees were not rated for the first one year (i.e., while they were on probation) data was not available for these employees. Whenever available, the last three years' performance rating was taken as the variable of interest.

Results

We used a set of statistical techniques called survival analysis, specifically Cox regression (Cox, 1972) and Kaplan-Meier analysis to study the impact of the independent variables on probability of turnover and employee tenure. These techniques though initially used in bio-statistics have been recommended for use in turnover research (Morita & Lee, 1989) and have subsequently been used to study turnover in a number of studies in a range of different contexts (Aarons et al, 2009; Adams, 1996; Bailey & Borooah, 2009; Chisholm, Russell, & Humphreys, 2011; Cho et al, 2012; Darden, Hampton & Boatwright, 1987; Dickinson & Painter, 2009; Gury, 2011; Hom & Kinicki, 2001; Hoverstad, Moncrief, Lucas & Davis, 1992; Hunton & Weir, 1996; Moncrief, Hoverstad & Lucas, 1989; Murtaugh, Burns & Schuster, 1999; Somers, 1996).

Life Tables

The initial life tables for the entire sample showed that the cumulative proportion of engineers surviving in the organization at the end of each of the thirteen years as given in Table 2. As expected the largest reduction in the population happens in the first year after joining with the incremental reduction in population surviving reducing over the years. The survival function for the entire population is shown in Fig. 1.

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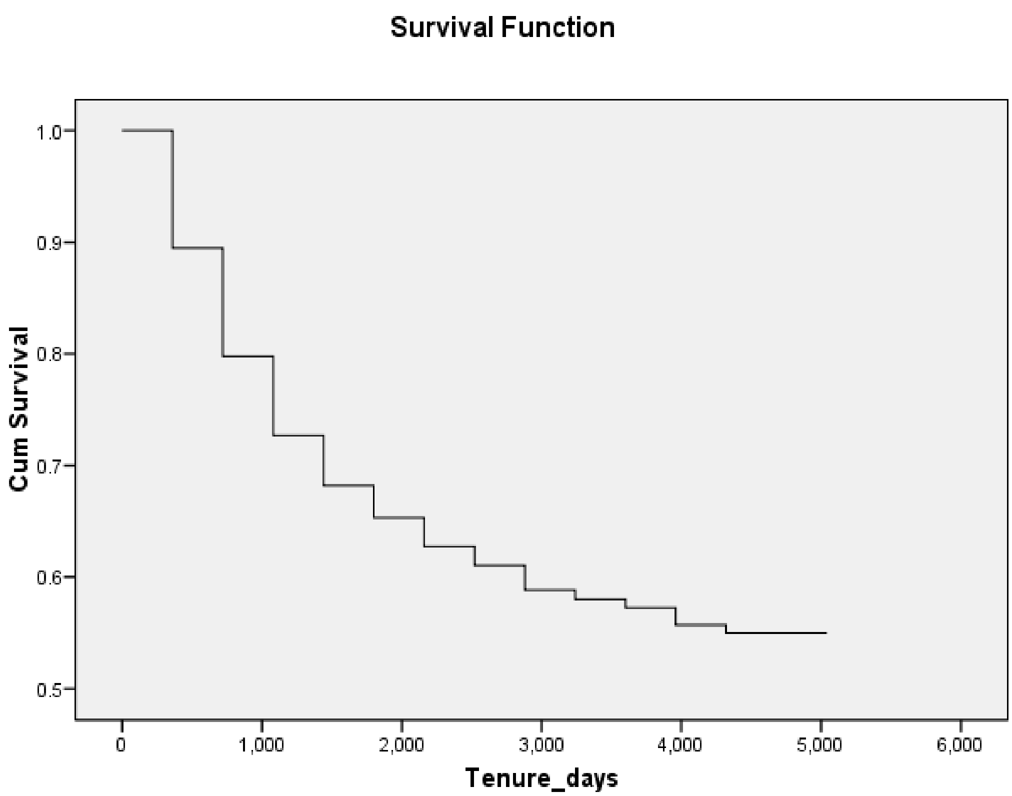
Cox Regression

Using Stata version 11 software, we tested the proportional hazards assumption using Schoenfeld residuals (phtest) which yielded a chi square value of 37.89 (p = .0000). Subsequent analyses were done using SPSS version 15.0. Following earlier studies (e.g., Cho, Lee, Mark & Yun, 2012) on attrition analysis, we used Cox proportional hazards regression (Cox, 1972) in two stages. First, each variable was tested in univariate regres-

Table 2 Life Table for the Entire Sample

Time elapsed since date of joining	Cumulative proportion of engineers surviving at the end of the time interval
Year 1	89%
Year 2	80%
Year 3	73%
Year 4	68%
Year 5	65%
Year 6	63%
Year 7	61%
Year 8	59%
Year 9	58%
Year 10	57%
Year 11	56%
Year 12	55%
Year 13	55%

Fig. 1 Survival Function for the Entire Population of Engineers



sion and those variables with $p \leq .01$ were included in the multivariate regression model. In addition, we also included gender and caste related variables for the case of completeness. Results of the regressions are shown in Table 3. We also tested for the interaction of gender and marital status; however, we found the interaction term to be non-significant.

Table 3 Output of Cox Proportional Hazards Regression Analysis

	Univariate			Multivariate		
	HR	95% CL	*p*	HR	95% CL	*P*
Year of joining*	1.042	[1.01, 1.07]	.003	0.790	[0.75, 0.82]	.000
Age*	0.466	[0.44, 0.49]	.000	0.448	[0.41, 0.49]	.000
Gender (0=male, 1=female)*	0.967	[0.73, 1.28]	.816	0.888	[0.60, 1.30]	.544
Married (0=unmarried, 1=married)*	0.069	[0.05, 0.09]	.000	0.465	[0.32, 0.67]	.000
Scheduled Caste (1=scheduled caste)*	0.888	[0.71, 1.09]	.269	0.821	[0.61, 1.09]	.183
Scheduled Tribe (1=scheduled tribe)*	0.899	[0.66, 1.22]	.499	1.046	0.63, 1.72]	.859
Other Backward Classes (1=other backward classes)*	0.497	[0.39, 0.63]	.000	1.008	[0.69, 1.47]	.967
Specialization in mechanical engineering	0.954	[0.81, 1.11]	.549			
Specialization in chemical engineering	0.898	[0.72, 1.11]	.326			
Specialization in instrumentation engineering	1.692	[1.01, 2.82]	.044			
Specialization in Electrical, Electronics, or Computer Science Engineering	1.073	[0.90, 1.27]	.427			
Location match (1=different region, 2=different state, same region, 3=same state)*	0.783	[0.71, 0.86]	.000	0.871	[0.76, 0.99]	.044
College ranking (1=premium college)*	2.042	[1.72, 2.42]	.000	1.539	[1.17, 2.00]	.002
Performance rating*	0.835	[0.82, 0.84]	.000	0.915	[0.89, 0.93]	.000

* Included in multiple regression, HR = Hazard Ratio CL = Confidence Limit.

In the univariate analysis, engineers were more likely to leave early if they were younger, unmarried, not specialized in instrumentation engineering, not belonging to OBC category, posted in a different region from their home region, from a premium college, and poor performers. In the multivariate analysis, engineers were more likely to leave early if they were younger, unmarried, from a premium college, posted in a different region from their home region, and poor performers. Of these five factors, being from a premium college had a hazard ratio of 1.539. This factor had the highest impact on increasing the likelihood of attrition. Among the factors that reduced the likelihood of attrition were, age, marital status, location match, and job performance with hazard rations of 0.448, 0.465, 0.871, and 0.915 respectively. The -2 Log Likelihood for the model was 3343.562 with Chi square = 1088.645 (p = .000).

Among the factors that reduced the likelihood of attrition were, age, marital status, location match, and job performance

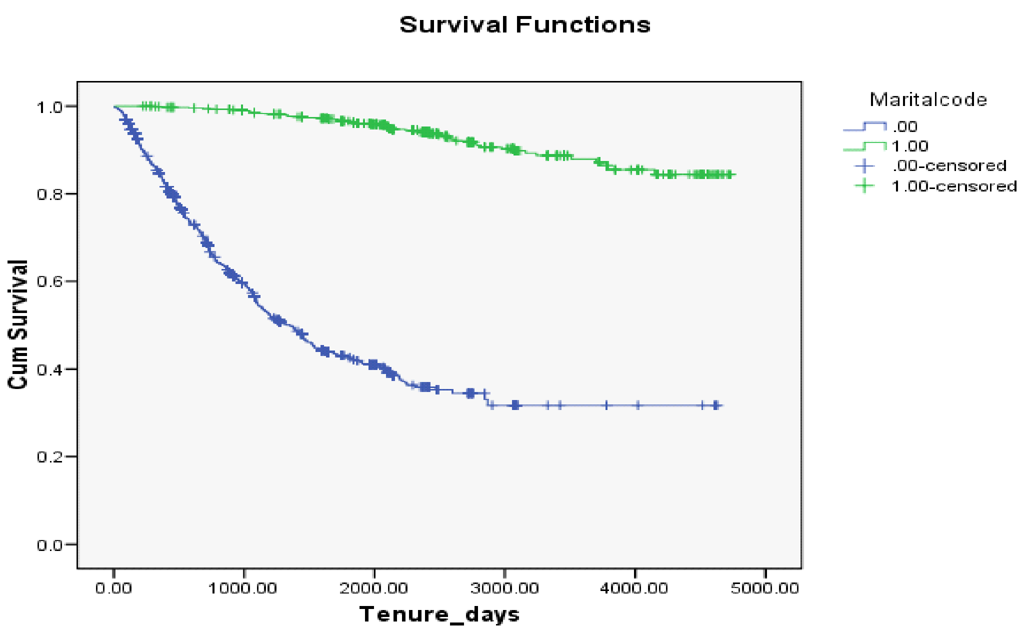
Since the company had a policy of rating employee performance only after the first two years of probation, the data on performance was available only for 1384 candidates, thereby leading to a reduced sample size. We performed the Cox regression twice- first without performance and next with performance to see if the reduction in sample size due to missing performance data was substantial. However the differences in the results were not substantial. Moreover, we felt that including performance as an explanatory variable was more important than the increased power from the larger sample, hence it was retained in the final analysis.

Kaplan-Meier Analysis

In order to understand the effect of the significant variables viz. marital status, location match, college ranking, and performance on tenure in more detail, we performed Kaplan-Meier Analysis.

The effect of marital status on the survival function is shown in Fig. 2. The mean tenure for unmarried engineers was 2131.48 days (*SD* = 75.33 days) while the mean tenure for married engineers was 4398.915 days (*SD* = 43.32 days). The Log-Rank (Mantel-Cox) test has Chi-square = 496.94 (*p* = .000).

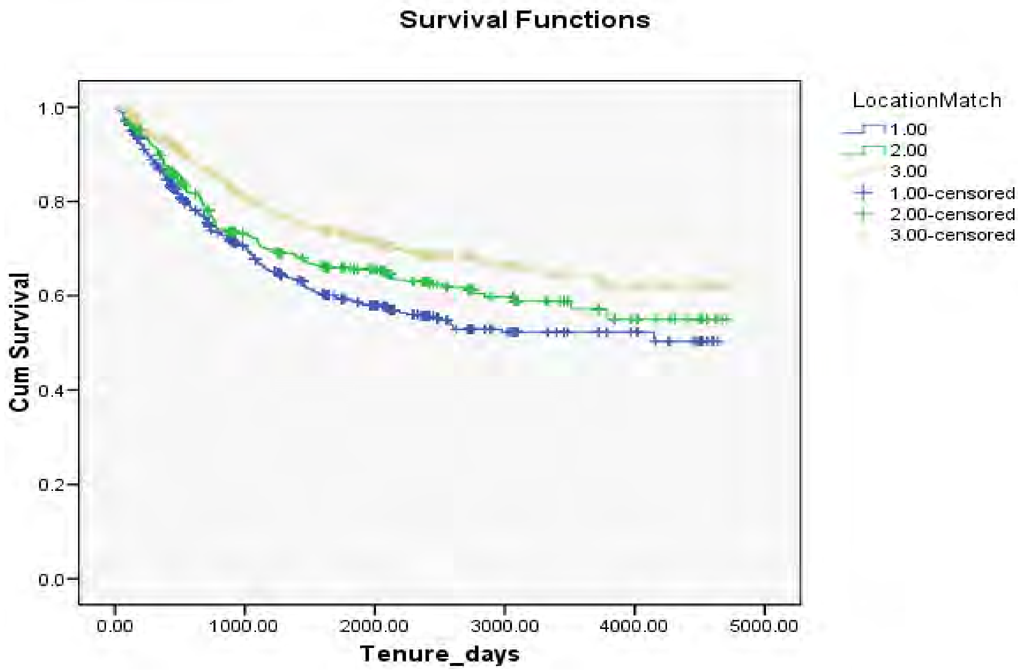
Fig. 2. Kaplan-Meier Plot for Marital Status



The effect of location match on the survival function is shown in Fig. 3. The mean tenure of engineers who were posted in a different region from their home state was 2848.13 days (*SD* = 78.23 days). The mean tenure of engineers who were posted in a different state from their home state, but the same region as their home state was 3120.06 days (*SD* = 97.22 days).

The mean tenure of engineers who were posted in the same state as their home state was 3441.77 days (*SD* = 86.88 days). The Log-Rank (Mantel-Cox) test has Chi-square = 26.23 (p = .000).

Fig. 3 Kaplan-Meier Plot for Location Match



The effect of the college ranking on the survival function is shown in Fig. 4. The mean tenure of engineers who were from an elite college was 2345.91 days (*SD* = 112.69 days) while the mean tenure of engineers who were from other colleges was 3294.89 days (*SD* = 54.98 days). The Log-Rank (Mantel-Cox) test has Chi-square = 69.73 (p = .000).

The effect of the performance rating on the survival function is shown in Fig. 5. For the purpose of this analysis, the average performance grade in the last three years (an ordinal variable) was considered. The performance grade ranged from 1=highest to 6=lowest. The mean tenure of engineers who were rated 1, 2, 3, 4, 5, and 6 was 4272.45 days (*SD* = 100.78 days), 4159.12 days (SD = 56.38 days), 3414.77 days (SD = 114.269 days), 1671.63 days (SD = 139.90 days), 654.21 days (SD = 31.54 days), and 730.00 days (SD = 0.00 days) respectively. The Log-Rank (Mantel-Cox) test has Chi-square = 945.28 (p = .000). It is heartening to see that the turnover is lower among individuals with high performance.

Discussion

Our analysis throws light on the drivers of on-the-job search in a government owned corporation in a developing coun-

Fig. 4 Kaplan-Meier Plot for College Rank

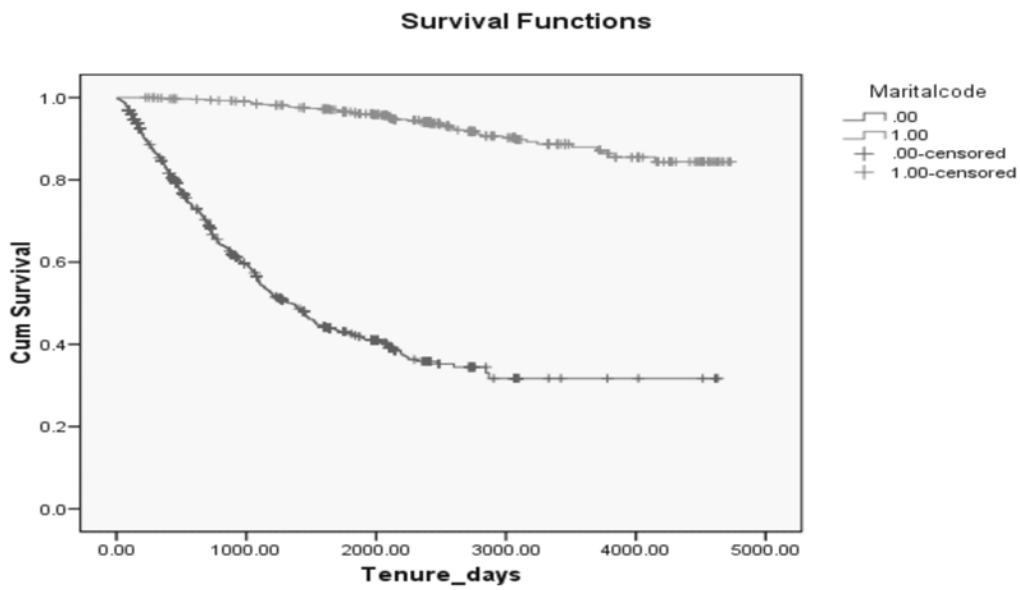
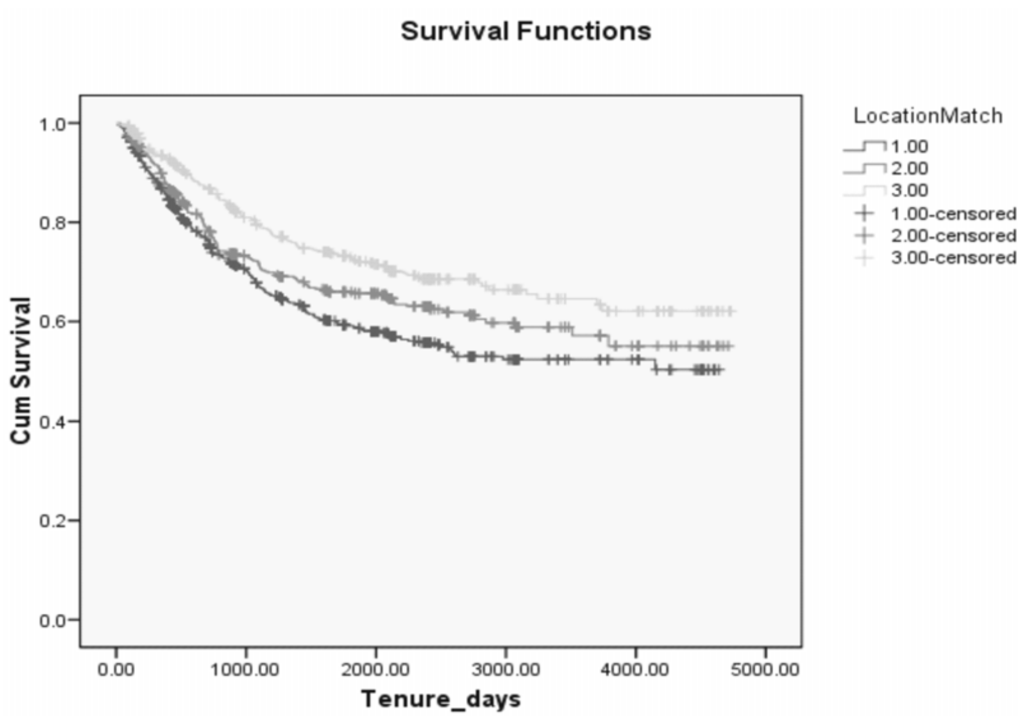


Fig. 5 Kaplan-Meier Plot for Performance Rating



try. As compared to an earlier study (Banerjee & Bucci, 1995) in this area, our findings are mixed. While like Banerjee & Bucci (1995), we too find that age and tenure are negatively related to turnover (and hence on-the-job search), contrary to their findings, we found that married persons were less likely to leave the organization and that caste had no impact on job search.

Age and tenure are negatively related to turnover. Married persons were less likely to leave the organization and that caste had no impact on job search.

In addition, we found that three other factors contributed to low organizational tenure viz. poor employee performance, poor location match, and elite college education. The fact that employees with poor performance are more likely to leave the organization is proof of the fact that the organizational culture supports and encourages meritocracy. The role of location match and elite engineering college in predicting turnover of engineers is interesting and has implications for future research. In a collectivistic culture such as India, the family is an important social unit, which influences career decisions, and hence the location of the home city plays an important role in career decisions of engineers. The organization may require its employees to travel across all locations in the country. In fact, this may even add to learning through diverse experiences and may be an important element in developing future leadership capability for a large organization. However, not all individuals may be equally mobile and for some, the location of posting may be a trigger for early departure from the organization. This can be tackled by organizations by providing a realistic job preview (Meglino & DeNisi, 2002; Phillips, 1998) in which candidates applying to the firm are acquainted with the possibility of being posted anywhere in India along with the associated challenges of such postings.

The other interesting finding is the role of elite colleges in predicting turnover. While most organizations strive for getting candidates from elite colleges due to their perceived higher ability and performance, this may not always be in the organization's interest. Organizations must regularly assess two aspects. First, whether individuals recruited from elite colleges indeed perform better in the organizational context. Second, organizations must assess if there are any costs (e.g., cost of early turnover) associated with hiring candidates from premium colleges which may offset the perceived benefits from hiring these candidates.

One area of further study is the role of macro-economic factors such as labor market dynamics in determining the turnover over the period from 2000 to 2013. We did a Kaplan-Meier test to analyze the effect of the year of joining on the mean tenure and we found that the mean tenure systematically decreased from 3841.34 days for engineers who had joined in 2000 to 332.72 days for engineers who had joined in 2012 with one exception. For engineers who had joined in the year 2006, the mean tenure was

2109.32 days while the mean tenure for engineers joined in the year 2005 was 1753.44 days and the mean tenure for engineers joined in the year 2007 was 1623.44 days. The reason for the tenure of engineers joining in 2006 being higher than that of the adjoining two years is that there was a salary revision in that year. Hence, it seems as if the salary revision has had its intended effect in terms of increasing the engineers' tenure.

Salary revision has had its intended effect in terms of increasing the engineers' tenure.

Conclusion

It has been forty years since Cox (1972) discovered the techniques for performing regression analysis on censored data and twenty-four years since Morita and Lee (1989) introduced these techniques to organizational researchers. Yet these techniques have been hardly used for turnover analysis by organizations (Somers & Birnbaum, 1999). This study demonstrates that survival analysis is a useful technique for the analysis of employee turnover and since employee data is already available in the company's database, it is often simply a matter of going through the analysis, which can reveal interesting insights in to the likely causes of employee turnover. Using this technique, organizations can also study the role of psychometric variables in explaining employee turnover (e.g., Chang, Choi & Kim, 2008; Hom & Kinicki, 2001; Mossholder, Settoon & Henagan, 2005; Trevor, 2001) or the role of recruitment sources in explaining employee turnover (e.g., Weller, Holtom, Matiaske, & Mellewigt, 2009). These psychometric variables in turn can be used for selection in order to improve the overall tenure of employees.

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