Manpower Planning using Markov Chain: A Case Study on Young Executives at Malaysian Retirement Fund (Incorporated)

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ABSTRACT
Modelling the manpower planning and human resource management in an organization mainly involved the prediction of future behaviour of employees. This is very crucial as manpower planning is the heart of an organization. Manpower planning is a systematic process that aids in identification of gap between current and future resources. This paper aims to determine an appropriate manpower model to understand the flow of young executives at Malaysian Retirement Fund (Incorporated). The model is developed using Markov chain approach. The focus group is generation-Y (millennial) employees who were born between 1980 and 2000.

Keywords— Employee turnover, generation-Y, Manpower planning, Markov chain.

I. INTRODUCTION
Traditionally, manpower planning is concerned with the numbers of people with the right levels and types of skills in an organization. Manpower planning, in specific, involves the turnover of employees where it continues to be a never ending issue in any organization.

Manpower planning is a forecast from current personnel inventories; the long-term formulation of plans for recruiting, assigning, and developing personnel. Without scientific and quantitative forecasting analysis on internal and external supplies which indicate by the turnover ratio of enterprise’s human resources, human resource (HR) department in an organization rely only on manager’s personal experience which is more to the qualitative judgments that can be questioned. As a result, wrong decisions of HR management, improper number of staff, and staff structural imbalance would occur. An efficient manpower planning leads to a better understanding of the ‘in’ and ‘out’ of an employee. This would help to resolve any employee shortfall or surplus that can be costly. One of the quantitative methods used to solve this type of problem is Markov Chain.

Numerous researchers like Bartholomew (1973), Bartholomew et al. (1991), Davies (1975, 1981, and 1982) have made significant contributions in the area of statistical manpower planning and control, especially with Markov models. In most studies, different aspects of maintainability (the maintenance of a given manpower structure through recruitment or promotion so that it remains the same at subsequent accounting periods) have been widely covered. Of the three factors of manpower flow (recruitment, promotion, wastage) only recruitment and promotion have been accepted as good control factors on the ground that exercising control through wastage (for instance, dismissal/retrenchment and inducement to leave) is undesirable and unacceptable (Price et al., 1980; Bartholomew, 1982).

The manpower issue particularly in ‘turnover’ has been described as being extraordinary and serious within the latest group of employees entering the workforce, the generation-Y (gen-Y) (Yusoff et al., 2013; Sujansky & Ferri-Reed, 2009), or young employees. The high turnover, particularly from gen-Y employees, has been the concern of HR managers within the Asian Pacific region. Malaysia is no exception in highlighting this issue in its major newspapers to convey the HR practitioners’ concerns that the turnover among this group is becoming prevalent.

Several studies reported that gen-Y employees in the Asian Pacific region have the shortest job tenure compared with other generations (gen-X and baby boomers). Gen-Y employees have 18 months of average job tenure, compared to 4 years for the other generations (Sheahan, 2008). Since gen-Y is the generation that will take over the job industry in near future, with their behaviours and characters, Markov Chain modelling is
very useful to predict their turnover. This study will be able to help not only organizations but other researchers in finding a way to reduce the turnover among gen-Y.

Gen-Y was chosen because they are the youth that will rule the country in the future. The reasons for high employment turnover among gen-Y employees are lack of career advancement, work load, relationship with other colleagues, alternatives job opportunities, job security, and stressed at work. However, they do not think that training program is the reason for them to join the organization or to stay in the organization. The issue of the increased job mobility among gen-Y employees is not only affect to the organizational effectiveness, in terms of the incurred financial and non-financial costs associated with a high turnover rate, but more importantly posing a threat to the economic growth of a country in several different ways (Abdelbaset et al., 2015).

Gen-Y manpower in Malaysia becomes more problematic as the country is encountering the issue of talent crunch, or alternatively called the shortage of talents (Downe et al., 2012). This motivates us to develop a Markov chain model for predicting the turnover of gen-Y using Malaysian Retirement Fund (Incorporated) as the case study.

II. LITERATURE REVIEW

Nowadays, ‘turnover’ has become a trend in working environment where it has increased rapidly from year to year. This has motivated many researchers to conduct studies on turnover more than five decades (Holtom et al., 2008). In gen-Y perspective, researchers have classified the society in different categories according to age (Palese et al., 2006). With different range of age, they have the same way of acting, thinking and feeling.

Gen-Y is also known as ‘millennial’. Millennials have different characteristics either in personality or their attitude or characteristic in the workplace. In the workplace, ‘baby boomers’ (born 1946-1964) is the type of generation that are loyal, respect towards the higher up in the hierarchy and patiently wait for their turn in advancement (Chi et al., 2013). For Gen-X (1960s-1980s), in their workplace, they tend to doubt on new systems, work independent, like to follow orders, and looking for opportunities that able to improve their skills. In their own perspective, when a job freedom is given, it is a reward given to them. They do not have any interest in titles and status (Park & Gursoy, 2012).

Gen-Y is the younger generation. However, they are faster learners in terms of their work. They always want clear descriptions from their managers or colleagues about the tasks they need to complete. They are looking for jobs that can provide long-term careers and job training. Since they look for a collective management style, they love to take challenging tasks. Thus, predicting the behaviour of gen-Y is quite critical in manpower planning. Understanding the trends in a manpower system plays a crucial part to enable a good planning of economic development in an organization. The unpredictable human behaviour and the social environment are two factors that are more likely will give impact to manpower planning. Hence, these trends can be easily understood by using stochastic processes. A stochastic process can be described as a sequence of events that are generated by probabilistic laws. These events occur randomly over time, but are governed by certain statistical and probabilistic rules.

Markov chain can aid in workforce planning. According to Selthare (2007), various stochastic models have been used in manpower planning. These models can be broadly classified into two types, Markov chain models and renewal models. In Markov chain models, the manpower system is graded into hierarchical, mutually exclusive and exhaustive grades. This implies that each member can only be in one grade at any given time. Members of the system move between grades due to promotion, demotion, or due to transfer to or from another department. Members of the system also can be moved out due to discharge, resignation, retirement or medical retirement. Selthare has focused on an optimization and estimation of stochastic models of manpower system incorporating one or more aspects of recruitment, promotion, training and wastage by using Renewal Theory, Markov Renewal Theory, Semi Markov Process, Stochastic Point Process and Product Densities.

Igboanugo & Edokpia (2014) had applied Markov chain in soft drink industry in Nigeria where a stable transition probability matrix was created based on five years data of manpower, recruitment, stock, wastage and retirement from three departments. The matrix enable the prediction of future manpower needs, and problems associated with current manpower policy also be examined when applying this method. Robbins & Harrison (2006) described manpower planning with limited hiring opportunities. They presented stochastic modelling; the objective function maximizes the differences between billable revenue, payroll costs, recruiting costs, training costs, and the expected cost of firing and subcontracting with the following constraints. (1) The overall staff balance constraint; in every skill and grade, the net change in manpower is equal to the number of new hires less the number lost to attrition or termination. (2) All new hires and retooled resources are designated as in training for one period. (3) The number of billable resources according to demand/supply. (4) An upper limit on the proportion of billable resources that can be subcontracted. (5) Balance the number of retrained resources.

De Feyter & Guerry (2011) mentioned that the objective of manpower planning is developing plans to meet the future HR requirements. Although alternative approaches have been introduced, for instances simulation techniques, Markov Chain Theory remains useful. The analytical Markov approach allows identifying interesting
characteristics of the manpower system which influence its future dynamics. Oczki (2014) has proved that the implementation of Markov chain results in higher effectiveness of HR policy and increased competitiveness of the organization. Two methods that used in his research are Markov chain model and simplified approach proposed by Taylor (2005) to forecast manpower supply. Markov chain model uses transitional probabilities and stock of employees at the beginning of period whereas a simplified approach does not require estimating probabilities but using turnover rate and fraction of vacancies. Output from this not even contributes to more accurate HR planning by reduction of HR costs but also improvement of company’s performance. Besides, it supports the process of managing recruitment costs and also facilitates the human capital management due to enhanced timing and targeting of promotions and training. The model can be implemented to forecast internal labour supply.

III. METHODOLOGY

This study aims to determine an appropriate manpower model to understand the flow of young (gen-Y) executives at Malaysian Retirement Fund (Incorporated). The main objective is to determine the percentages of young executives, in the long run, that will leave the organization through wastage and promotion. This would help the management to understand and find possible solutions to reduce the turnover rate among the young executives.

The model development process is illustrated in Figure 1. To model the flow of manpower in an organization as a Markov chain model, one must define the stage interval and states, data preparation will come after that, estimate the transition probability matrix (TPM) and validate the model. The first step in model development is the decision on what stage interval (time period) to use; weekly, monthly, yearly etc. A small time interval would probably produce accurate estimates of TPM. In this case we will use monthly data to construct the TPM.

In order to decide whether the model is good or not, model validation is necessary before the model can be used for forecasting and analysis. In general the choice of stage interval should be guided by the planning decision and objectives of the study. Since the objective of this study is to determine an appropriate manpower model and to understand the flow of gen-Y in Malaysian Retirement Fund, a five-year monthly period is used as the time interval. This is the reasonable time frame for promotion (one of the state defined in this study) and quite a common experience.

The most critical step in Markov chain modelling is the selection of states to which the organization can be classified and to achieve the objective of the study. The number of states should be determined carefully. The number of states should not be too small or too big to avoid the confounding effect and may cause the poor estimate of TPM.

Table 1: State and Description

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen-Y Wastage</td>
<td>Reduction in size of the executive by termination and voluntary resignation.</td>
</tr>
<tr>
<td>Gen-Y Promotion</td>
<td>Promoted to next level, Management level</td>
</tr>
<tr>
<td>Gen-Y Stock</td>
<td>Current employee at the same position</td>
</tr>
<tr>
<td>Gen-Y Study Leave</td>
<td>Company provide opportunity to take a study leave (a maximum of 2 years)</td>
</tr>
</tbody>
</table>

The five-year data of manpower wastage (resigned and termination), promotion, stock and study leave were obtained from company records. Table 1 describes the various states. As can be seen in the TPM loop of Figure 2, four stages are involved. An active staff can move to promotion (since we only focus in the executive level) if the staff does not get wasted through termination and voluntary resign. Same goes to a staff at stage study leave. The long run movement of staff can be stable and be treated as Markov chain.

The data were taken from the primary records of human resource statistics. The whole database consists of two distinct databases; (1) employees who left their jobs from 2012, and (2) active staff (as at Sept 2015).
$P_2$ = the probability a staff is promoted; 
$P_3$ = the probability a staff is stocked (same position); 
$P_4$ = the probability a staff is given a study leave.

Figure 2 shows that the TPM for turnover of the gen-Y executives at Malaysian Retirement Fund is the TPM for absorbing Markov chain. Thus, to achieve the main objective of this study, we need to find the limiting probability matrix for this absorbing matrix.

From a TPM $(P)$, to be estimated from HR data, the corresponding future distribution, $P^n$, after $n$ years (as $n \to \infty$) can be constructed. A Markov chain is called an absorbing Markov chain if:

(a) there are one or more absorbing states, and
(b) from each non-absorbing state it is possible to reach some absorbing state in one or more steps.

Consider an absorbing Markov chain with TPM in the form

\[
P = \begin{bmatrix} 1 & 0 \\ R & Q \end{bmatrix}.
\]

The matrix $(I - Q)$ is invertible, and the $n$th power of $P$ is

\[
P^n = \begin{bmatrix} 1 & 0 \\ (I - Q)^{-1}R & Q^{-1} \end{bmatrix}.
\]

However, as $n \to \infty$, $Q^n \to 0$. Hence, we may write

\[
P^n = \begin{bmatrix} 1 & 0 \\ (I - Q)^{-1}R & 0 \end{bmatrix}.
\]

### IV. RESULTS

Table 2 shows the statistics of resigned/terminated staff at Malaysian Retirement Fund from 2000-2005 data. Gen-Y turnover is higher at Executive level with 14.9%. Factors related to employees’ behaviour towards organization were highly contributed to this percentage. Some of them decided to find other jobs (resigned) while others remain at the organization which ended with poor performance (terminated). On the other hand, employees’ satisfaction through pay raises, bonuses, promotions and other incentives lead to low turnover rates.

<table>
<thead>
<tr>
<th>Level</th>
<th>Group</th>
<th>Number of Resigned/Terminated Staff</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clerical</td>
<td>Gen Y</td>
<td>32</td>
<td>9.17%</td>
</tr>
<tr>
<td></td>
<td>Gen X</td>
<td>42</td>
<td>12.03%</td>
</tr>
<tr>
<td></td>
<td>Baby Boomers</td>
<td>106</td>
<td>30.37%</td>
</tr>
<tr>
<td>Executive</td>
<td>Gen Y</td>
<td>52</td>
<td>14.90%</td>
</tr>
<tr>
<td></td>
<td>Gen X</td>
<td>46</td>
<td>13.18%</td>
</tr>
<tr>
<td></td>
<td>Baby Boomers</td>
<td>32</td>
<td>9.17%</td>
</tr>
<tr>
<td>Management</td>
<td>Gen Y</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Gen X</td>
<td>13</td>
<td>3.72%</td>
</tr>
<tr>
<td></td>
<td>Baby Boomers</td>
<td>26</td>
<td>7.43%</td>
</tr>
</tbody>
</table>

As mentioned earlier, five-year data was used to study the staff flow in and out, and it is a reasonable time frame for promotion. Since we are focused only on gen-Y Executive level, only four states were considered; wastage, promotion, stock and study leave. Table 3 shows the TPM having the elements of the non-absorbing states namely wastage and promotion.

Table 3: Transition Probability Matrix

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Wastage</th>
<th>Promotion</th>
<th>Stock</th>
<th>S. Leave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastage</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Promotion</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stock</td>
<td>0.0390</td>
<td>0.0565</td>
<td>0.7488</td>
<td>0.1557</td>
<td></td>
</tr>
<tr>
<td>Study Leave</td>
<td>0.0873</td>
<td>0.0794</td>
<td>0.6825</td>
<td>0.1508</td>
<td></td>
</tr>
</tbody>
</table>

The TPM was constructed from 2010-2015 data. From personnel data, the five-year transitions by states were tabulated manually. One difficulty in the data is every individual record has to be examined. The limitation can be minimized if a computerized database that could extract necessary individual information is realized. But with the current system, it is not possible. The main findings from TPM are:

1) Wastage and Promotion are the absorbing states.
2) The highest probability is from Stock to Stock, followed by from Study Leave to Stock.
3) The probability that the organization will loss gen-Y executives (Wastage or Promotion) is $0.0390+0.0565 = 0.0955$.
4) The probability that the organization will loss gen-Y executives after Study Leave (Wastage or Promotion) is $0.0873+0.0794 = 0.1667$.

From the TPM given in Table 3, the probabilities for wastage and promotion can be calculated. For an absorbing Markov chain, as mentioned earlier, we need to find the limiting probability matrix, as follows:

\[
W = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}, \quad P = \begin{bmatrix} 0.0390 & 0.0565 & 0.7488 & 0.1557 \\ 0.0873 & 0.0794 & 0.6825 & 0.1508 \end{bmatrix}
\]

\[
(I - Q)^{-1} = \begin{bmatrix} 0.7488 & 0.1557 \\ 0 & 0.6825 \end{bmatrix} = \begin{bmatrix} 0.2512 & -0.1557 \\ -0.6825 & 0.8492 \end{bmatrix}
\]

\[
(I - Q)^{-1}R = \begin{bmatrix} 7.9365 & 1.4551 \\ 6.3785 & 2.3477 \end{bmatrix}; \quad \text{hence}
\]

\[
(I - Q)^{-1}R = \begin{bmatrix} 0.0390 & 0.0565 \\ 0.0873 & 0.0794 \end{bmatrix}
\]
Thus, the limiting probability matrix for the turnover of gen-Y executives at Malaysian Retirement Fund as \( n \to \infty \) is

\[
P^* = \begin{bmatrix}
W & P & S & SL \\
W & 1 & 0 & 0 & 0 \\
P & 0 & 1 & 0 & 0 \\
S & 0.4363 & 0.5637 & 0 & 0 \\
SL & 0.4535 & 0.5465 & 0 & 0 \\
\end{bmatrix}
\]

Based on the above limiting probability matrix, in the long-run, 43.63% of the staff from the stock (existing staff) left the organization through wastage while 56.37% left through promotion. From study leave, respectively, 45.35% and 54.65% left the organization through wastage and promotion.

V. CONCLUSIONS

A turnover can affect an organization. Turnovers from any generation and any designation will affect an organization as a whole. This section will conclude on the benefits of predicting the employees’ turnover in the scope of young (gen-Y) executives at Malaysian Retirement Fund (Incorporated). As mentioned earlier, this is a study on the Executive level in which they are more likely to resign as compared with other levels. We will look at the organization perspective (Malaysian Retirement Fund) and also public perspective since the organization manages public fund.

High rate of employees’ turnover can lead to lower organization productivity and efficiency. Employees or staffs who have more experience will be more aware of the organization’s operations, policies and goals, and how to act in line with their roles in the organization. An organization such as Malaysian Retirement Fund will tent to avoid high turnover rate due to their strategic goals in assuring the world class retirement fund to their more than 11 million members. Thus, predicting the future turnovers is crucial to increase efficiency and productivity.

Morale in high-turnover organizations is normally weak or fragile. Organizational culture is the shared good values of a group of employees who work together. Encouraging all staff to share the same vision of an organization and outperform in every given task is difficult when colleagues and co-workers are vanishing around them. Workplace relationship is the key to an employee’s satisfaction. As colleagues and co-workers leave, the remaining employees constantly have to cycle through the process of getting to know new employees.

High rate of employees’ turnover lead to higher costs related to recruiting and training new employees. An organization has to allocate more resources (time, staff and money) to hire and train new employees, and this would disrupt revenue-generating activities. Experienced workers who have to frequently train new employees are less able to concentrate on their normal works. High turnover can also make the remaining employees more stressed due to the many gaps until new employees are hired and trained. Internal labour supply forecast contributes to a more accurate HR planning and proper utilization of human resources. As a result, it is not only give an impact to the operational cost (reducing HR costs) but also improve the organization’s performance.

The combined negative effects resulted from high turnover may cause an organization to generate less profit. Thus, by looking at the future turnover, all negative effects from the high turnover can be avoided or managed, and the organization can increase the productivity and reduce operational costs which lead to additional profits.

This study has demonstrated that not only the effective application of Markov chain to manpower planning, specifically on predicting the future turnover, but also the benefits of looking at the future turnover. The pattern of young executives’ turnover at Malaysia Retirement Fund has shown that 43.63% of them left the organization through wastage (resigned or terminated) while 56.37% left through promotion. Also, among the employees who were given study leave, 45.35% and 54.65% left the organization through wastage and promotion, respectively.

REFERENCES