DOI: 10.17626/dBEM.ICoM.P01.2012.p011

HUMAN RESOURCE PLANNING FOR UNIVERSITY TEACHING SYSTEM

Dinesh Kumar [(1)] Khurana, P.K. Kapur [(2)]
[(1)]Department of Operational Research, University of Delhi, Delhi, India
[(2)]Amity International Business School, Amity University, India
E-mail: denesh.khurana@yahoo.ca

Summary: Human beings are considered as the most vital, crucial, volatile and unfathomable resource that any organization uses. In the event of the organization failing to place and direct human resource in the right areas of any activity, be it a university teaching system, business/production house serious inefficiencies are likely to occur. In order to achieve this, the co-ordination of demand and supply is necessary, coupled with monitoring and assessment of productivity and technological changes. Staff moves around the organization in a variety of flows. It is not only difficult but also impossible to track and monitor these movements/flows for a fairly large organization without mathematical modelling. This paper makes use of the technique called Markov Chain Analysis in a University Teaching System. The entire mathematics used in the paper has been embedded in the application software developed for the purpose. The HR manager with no background of mathematics can use the software and get answers to the typical HR planning questions.

Keywords: Movements/Flows, mathematical modelling, Markov Chain Analysis, typical HR planning questions

1. INTRODUCTION

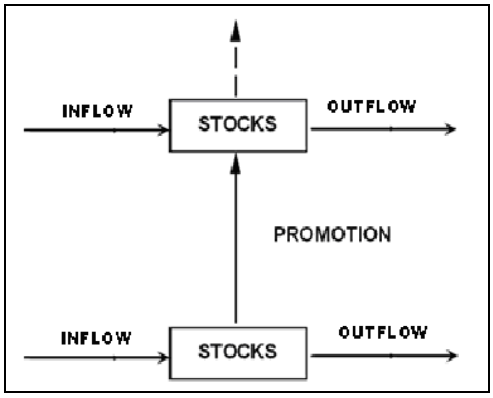
In the present days of intense competition, the organizations are focusing on their core businesses and the other functions are being outsourced. HR was regarded as normative and optimistic and was thought that HR professionals are missionaries and the social science should be used to improve the society refer Warner (1997). Skinner raised the question of HR in his article "Big head, no cattle" –Skinner (1981). Ulrich asked the question "Should we do away with HR?" refer Ulrich (1998). The authors of this paper consider that HR is becoming multi disciplinary and is striving to succeed in strategic direction McKenzie and Melling (2001) forecast that human capital planning will become a strategic driver because today the key issue is " Ensuring that the right people with right skills are in the right jobs at the right times". Human Resource moves around the organization in variety of ways it is not feasible to track and monitor these movements/ flows for a large organization without using mathematical modelling. In a University teaching system, the available information could be total number of teaching faculty in each level (e.g. number of lecturers/ Asst. Professors etc.) on the roll of the university department wise/ institute wise, Promotion to higher positions, attrition rates in different levels department/ institute wise, current state of the organization, future state based on current trends/future plans etc. In fact, the requisite information is fed to the computer application software developed for the purpose. The output of the software helps in evaluating various strategies that we adopt in the current as well as in the near future. The system is flexible to encompass changes in the environment or policy parameters of the organization. In the beginning of the 1970s, many companies were planning considerable expansion. During this period, it was realized that the key to success was sufficient supply of skilled personnel. This lead to the emergence of human resource planning as a tool of human resource management. HR planning is the process of ensuring that the correct numbers of human resources are available at the right time and the right place. In order to do that, they

needed appropriate analytical tools. A lot of effort was devoted in developing the tools and techniques to assist the managers with their planning. Many of these were based on the concept of Markov chains refer Bowel (1974). In a large university teaching system, the flow of individuals between various levels is a task, which requires a careful and strict monitoring. Over a number of years, patterns of behaviour may emerge and in many cases, the role of HR planning is to build a picture of such resource movement. In a stabilized environment where the features and characteristics are expected to evolve in a predictable and orderly fashion, a model of long-term pattern would emerge. This would show the expected number turnover of the staff, retirement, and average number of staff that leave due to voluntary/involuntary reasons. This can give basic picture of staff turnover. Information can be used for timings and the number for inducting new staff.

2. HR PLANNING MODELS & PROBLEM CONCEPTUALIZATION

There are generally following two types of HR Planning namely, aggregate planning and succession planning. Aggregate planning anticipates needs for groups of employees in specific levels i.e. lecturers, senior lecturers, assistant professors etc. Whereas the succession planning focuses on key individuals i.e. Heads of Institutions/ Departments, Pro- Vice Chancellors etc. that the organization needs to make sure that these are always remain filled. This paper deals with aggregate planning for the teaching faculty only, whereas a similar logic can be applied for the non- teaching staff. HR models may belong to a variety of categories. HR models were thought as mathematical representations of the relationships of a HR system. Representations are normally in the form of mathematical equations, which themselves express the HR process. HR systems are normally considered as complex systems in which their counterparts interact with each other to accomplish the desired outcome refer Khoong (1996). A typical HR system is presented in Figure 1. Rectangles represent “stocks” and arrows represent movements between various hierarchical levels of the organization/ the outside worlds are called as “flows”.

Figure 1: Typical HR system



Estimates of existing supply of human resource are not static. In a large university teaching system, employees change positions and job levels continuously. In order to assess the supply of employees there was the need to assess movement within the organization as well as the attrition rates in each level. This can be done through an Operational Research technique called “Markov Chain “. This technique describes probability of employee staying in the job in any category, moving to another job, or leaving the organization over a given period of time say one year/6 months/3 months/a month etc.

2.1 MODEL FORMULATION

The basic equation, which occupies a prominent role in most application of Markov Chain models, is as below. For details refer Bartholomew (1963a, 1963b, 1963c, 1991).

$\mathbf{n}(T) = \mathbf{n}(T-1)\,\mathbf{P} + \mathbf{R}(T)\mathbf{r}$

$\mathbf{n}(T)$ = A column vector at time T whose elements are $\mathbf{n}_j(T)$, j = 1,2 ……. k
(Each $\mathbf{n}_j(T)$ is a row vector).

$\mathbf{n}(T-1)$ = A column vector at time (T– 1) whose elements are $\mathbf{n}_j(T\text{-}1)$, j= 1,2….k
(Each $\mathbf{n}_j(T-1)$ is a row vector similar to the one defined above).

$\mathbf{P}$ = Transition probability matrix explained below.

$$\mathbf{P} = \begin{pmatrix} P_{11} & P_{12} \ldots\ldots P_{1k} & a_1 \\ P_{21} & P_{22} \ldots\ldots P_{2k} & a_2 \\ P_{31} & P_{32} \ldots\ldots P_{3k} & a_3 \\ P_{k1} & P_{k2} \ldots\ldots P_{kk} & a_k \end{pmatrix}$$

Where

P_{ij} = Probability that an individual in level i at the start of the time interval is in level j at the end. i,j=1,…….,k.

a_i = Probability that a member of level i at the start has left by end of the interval. i=1,…….,k.

It may be pointed out that the sum of the elements of each row of probability matrix =1- a_j, j= 1,…...,k.

$\mathbf{R}(T)$ = Total number of inductees at time T.

If these inductees

are allocated to k levels with probabilities $r_1, r_2, r_3, \ldots r_k$ such that

$\left\{ \sum_{i=1}^{k} r_i = 1 \right\}$ then $\mathbf{r} = \{r_i\}$ is called as induction vector.

3. DEVELOPMENT OF SOFTWARE

All the mathematical computations required in the Markov Chain model have been embedded in the software. A few simple inputs are required for the software to evaluate any option with regard to induction, promotion, attrition rate etc. The software takes into account variation of sizes in levels within a fixed global total or otherwise. Refer Kapur, Khurana and Seth (2008). The software provides answers to the following typical questions.

- What should be the intake during the fixed time interval (yearly, half yearly, quarterly etc) in each level to maintain or vary a specified inter-level structure?
- What should be the promotion prospects of the individuals in the system?
- What effect expansion or reduction will have on promotional avenues?
- How many people are needed over next 5 to 10 years?
- In which level or function do we need them?
- What skill do we expect them to have?

Input data required for the software may be collected as follows.

- Policy parameters of the organization i.e. age of retirement, qualitative and quantitative requirements (QRs) for promotion to next higher group etc.
- Attrition rate during next 5 years or so both due to superannuation and resignation etc.
- Desired inter-level structure of the institution by a specified time.

To find answers to above questions, a range of HR matrices will be required. This may include comparative staff attrition, overall number of leavers and joiners and so on.

4. PROBLEM FOR IMPEMENTATION

The data in Table 1 below relate to a large private university teaching system of the four levels i.e. Senior Professor, Professor, Assistant Professor and Lecturer for the two academic years 2009-10 and 2010-11. Flows for a university Teaching System are shown academic year wise.

Table 1: Flows for a university Teaching System in the examined academic years

Levels	**L**	**AP**	**Prof**	**Sr Prof**	**Turnover**	**Total**
2009-10						
Lecturer (L)	1580	80	0	0	90	1750
Asst Prof. (AP)	0	620	20	0	30	670
Prof. (P)	0	0	550	0	10	560
Sr. Prof. (P)	0	0	0	200	80	280
2010-11						
Lecturer (L)	1780	50	0	0	80	1910
Asst Prof. (AP)	0	650	40	0	30	720
Prof. (P)	0	0	600	20	0	620
Sr. Prof. (P)	0	0	0	250	90	340

Source: own research

In actual practice, propensity to leave depends on the length of service or seniority in the relevant level. Similarly, the promotion probabilities depend upon the length of time persons have spent in their current levels. In real time scenario, it is desirable to define the classes within each level. The beauty of Markov Model is that the classes can be defined as per requirement of the problem. In fact there can be different number of classes in each level. In the above University teaching system, the classes are defined thus: Lecturer/Senior lecturer level has been broken into three classes. Class 1 (C1) comprises lecturer with 0-2 yrs as lecturer. Similarly C2 compromises lecturer/Sr. lecturers of 2-4 years seniority and Class 3 (C3) will be of those with seniority more than 4 yrs as lecturer/Sr. lecturer. Class 4 (C4) is class of Assistant Professors with seniority within 2 years as Assistant Professor and Class 5 (C5) consists of Assistant Professor of seniority between 2-4 years as Assistant Professor, whereas Class 6 (C6) is of Assistant Professor with seniority above 4 years. Class 7 (C7) and Class 8 (C8) are of Professors with 0-2 years and 2 years and more as Professor respectively. Class9 (C9) is a single class, at the level of Senior Professor.

Transition Probability matrix for a total of nine classes is given in Table 2 below.

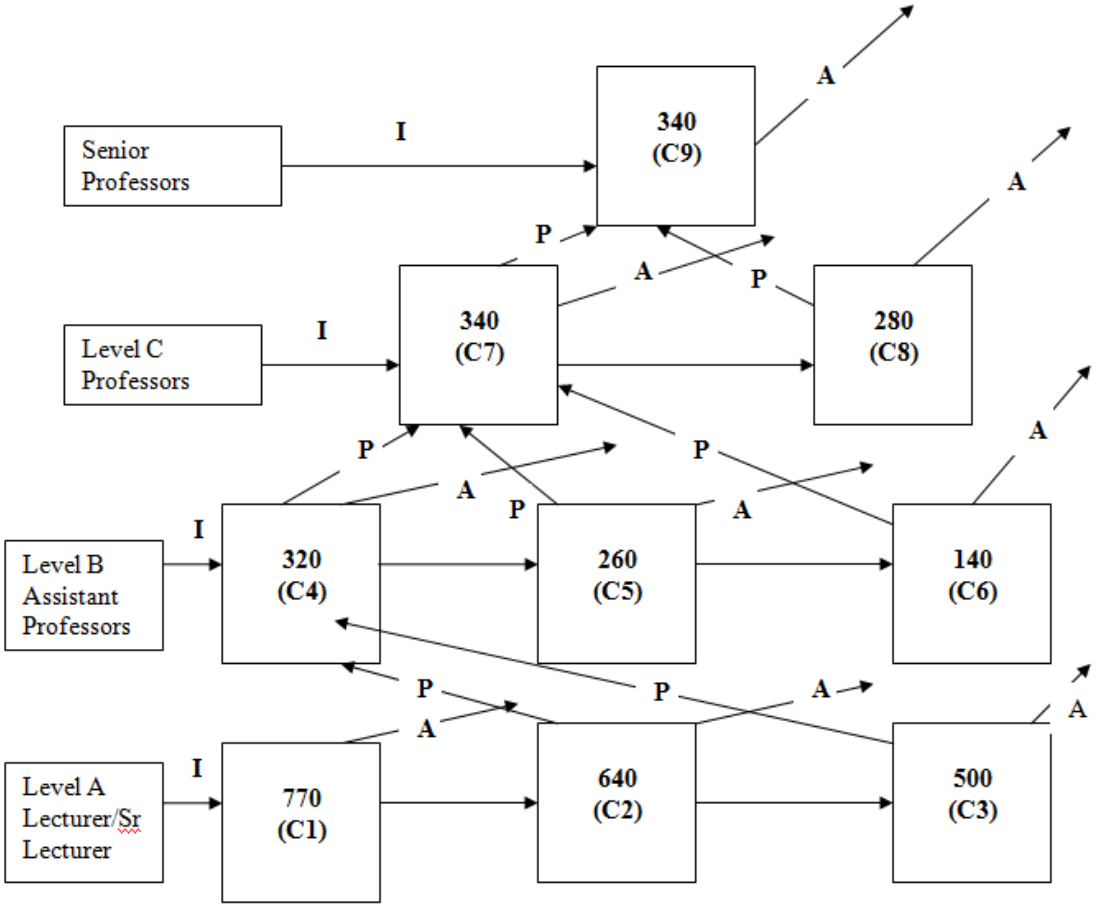
Table 2: Transition Probability matrix for a total of nine classes

Levels / Classes		Level 1			Level 2			Level 3		Level 4
		C1	C2	C3	C4	C5	C6	C7	C8	C9
Level 1 (L1)	C1	0.40	0.33	0	0	0	0	0	0	0
	C2	0	0.33	0.24	0.10	0	0	0	0	0
	C3	0	0	0.26	0.205	0	0	0	0	0
Level 2 (L2)	C4	0	0	0	0.44	0.27	0	0.13	0	0
	C5	0	0	0	0	0.37	0.27	0	0.13	0
	C6	0	0	0	0	0	0.20	0.033	0	0
Level 3 (L3)	C7	0	0	0	0	0	0	0.51	0.32	0.06
	C8	0	0	0	0	0	0	0	0.45	0.19
Level 4 (L3)	C9	0	0	0	0	0	0	0	0	0.64

Source: own research

The above transition probabilities were calculated based on the data for the academic year 2010-11 given in Table 1 above coupled with the data shown for each class in the pictorial description of the above system in Figure 2 below, e.g. the value for the cell at the first row and first column is 770/1910 = 0.40 and similarly for the other cells.

Figure 2: pictorial description of the examined teaching system



Source: own research

Legend:
P: Promotion, **I:** Induction, **A:** Attrition, **C1:** Class 1, **C2:** Class 2, **C3:** Class 3, **C4:** Class 4, **C5:** Class 5, **C6:** Class 6, **C7:** Class 7, **C8:** Class 8, **C9:** Class 9

Data for voluntary attrition rate level wise was calculated based on averages of previous years, whereas figures in respect of involuntary turnover was computed on the basis of ages of current employees and other reasons.

A set of promotion parameters for a particular University Teaching System were considered and fed to the application software developed for the purpose.

It may be mentioned that the induction, promotion, attrition are happening simultaneously in dynamic fashion. It is like a moving car, where people are embarking disembarking at constant basis round the year. The problem on hand was to carry out the induction so that the requirement of a university is met and at the same time ratio between **L**, **AP** and **P** is maintained as 1:2:4 or any other desired by the university teaching system.

The application software encompasses any possible number of hierarchal levels, calculates the transition probabilities required by the model.

Top management can envision the structure of the organisation for any number of years in future. Intervention of intake/promotion can be made for any level(s) in future years.

The following values were fed to the application software:

Number of classes (3 within Lecturer level, 3 within Asst Prof level, 2 within Professor level and just one in Senior Professor level) Thus the total number of classes say, K= 9

Number in each class say, N (Refer Figure 2)= [770, 640, 500, 320, 260, 140, 340, 280, 340]

Number of persons being inducted in each class of the above nine classes, during a unit time say, I vector = [160,140, 100, 80, 60, 60, 60, 40,10]

$$\mathbf{P} = \begin{pmatrix} .40 & .33 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & .27 \\ 0 & .33 & .24 & .10 & 0 & 0 & 0 & 0 & 0 & .33 \\ 0 & 0 & .26 & .205 & 0 & 0 & 0 & 0 & 0 & .535 \\ 0 & 0 & 0 & .44 & .27 & 0 & .13 & 0 & 0 & .16 \\ 0 & 0 & 0 & 0 & .37 & .27 & 0 & .13 & 0 & .23 \\ 0 & 0 & 0 & 0 & 0 & .20 & .033 & 0 & 0 & .767 \\ 0 & 0 & 0 & 0 & 0 & 0 & .51 & .32 & .06 & .11 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & .45 & .19 & .36 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & .64 & .36 \end{pmatrix}$$

5. SAMPLE OUTPUT OF SOFTWARE

The sample output of the software is shown in Table 4 below.

Table 4: Sample output of the software

Level	C1	C2	C3	C4	C5	C6	C7	C8	C9	Total	I
2010	770	640	500	320	260	140	340	280	340	3589 (100%)	710
2011	760	748	596	336	271	140	346	291	228	3716 (103.5%)	1290
2012	761	752	624	341	274	267	274	315	206	3248 (104%)	1110
2013	759	769	645	298	360	279	336	291	346	4083 (113.7%)	1328
2014	760	748	678	456	336	271	340	280	320	4189 (116.7%)	1250

Source: own research

It may be observed from above that structure of the organization can be visualized by changing any value of N and I and the corresponding output can be observed and appropriate decisions taken.

6. CONCLUSION & DISCUSSIONS

The fundamental point of the HR planning is to plan for both the number of people and skills that they will need to deliver the organization strategy. The world is complex dynamic and multidimensional whereas paper is flat. How we represent the rich visual world of experience and measurement on a flat surface. The preparation of HR planning is seen as continuously changing and therefore it requires regular updating. No sooner it is prepared it will have changed. The most basic theory for HR Planning in a university teaching system is to make sure that we have access to the data about the deployment of people in the organization, especially in a large university teaching system. People join, leave, some work as visiting faculty, part-time and some are temporary. Generally, people are on move and tracking them is difficult. The only answer to this kind of situation is to take a snapshot of the HR planning on a particular date of the year. University payroll system is the best source to authenticate the information.

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