Computing, Performance and Communication Systems (2021) Vol. 5: 11-16
Clausius Scientific Press, Canada

DOI: 10.23977/cpcs.2021.51003
ISSN 2371-8889

A Human Capital Dynamic Network Model Based on Monte Carlo Method

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Keywords: Hr, Dynamic network, Monte carlo, Stochastic simulation

Abstract: The human capital network model based on the actual situation of the company is established, and its dynamic process is mainly studied. First of all, some assumptions and definitions are given to describe the external turnover and internal mobility of employees, and all employees are assigned to appropriate positions by considering the details. Secondly, considering the turnover, recruitment and promotion of employees, we build a dynamic model to describe the changes of employees in the human capital network, and give the specific algorithm steps. Finally, according to the model and algorithm, the change of the company's human capital is simulated, and the optimized management strategy is given.

1. Introduction

Human resource management is a dynamic process rather than fixed, it includes promoting, churning and recruiting. Human capital management office through improve human manage build the group, and formation the modern organizations. The department of human capital can be found the churn of the former employee can influence staff, it led to difficult for recruiting [1-2]. Therefore, the human capital office takes actively measure to deal with 8%~10% recruiting positions the hard phenomenon. To discuss human capital network model for the influence of the staff recruiting, churn and promotion. In order to build a best group, especially, an efficient organizational structure, the human resource specialists take several measures. In the organization of human resource management department, there have many factors to influence succeed, in order to reach a best structure, using network model to find the risk about the churn of employee[3].

To solve the personnel situation, divide the level of position into seven classes, for instance, senior manager, junior manager, experienced supervisor, inexperienced supervisor, inexperienced supervisor, experienced employee, inexperienced employee, and administrative clerk. In the project list, we know that employee exist the churn, in order to change the phenomenon, the company adopt some steps, for example, recruit or through the lower rank to the higher rank promote, meanwhile, the rank only appear in the adjacent layers, promote and recruit need to meet some conditions. We establish of a dynamic network model to discuss the relative problem. Using month as unit, and then to divide 2 years into 24 steps. The current state transfer to the next state of process has involved employee churn, recruit, promote, and so on. Above-mentioned a series of processing is a dynamic process. All positions in the company, each state represents in current state whether have persons or not in the process of state transition, we should consider the factors that organizational churn, direct and indirect effects on the organization's productivity, budget the cost of recruit, training in each state, all location of the vacancy rate cannot so high. The changes of each factor, such as the churn of staff, recruit, promotion and so on[4-5].

Although the previous research has made some achievements, it rarely takes every employee of the company as the research object to consider the details and give the dynamic change process of the company personnel. In view of this,we use the way of Monte Carlo. According to the actual situation of the company, adopt random simulation.

2. Description of the Problem

The changes 7 level of position, we build a state transition model to solve it. To discuss and analysis the changes of organization's personnel situation, organization churn and direct and indirect effects on the organization's productivity, budget the cost of recruiting and training in the next 2 years for the company. Using month as unit, and will be divide 2 years into 24 steps. Each step is a dynamic network which is included 7 nodes. The whole network presence some problem, such as churn, supply and the internal flow (the lower position promote to a higher position), each node exist impact on each other (churning to diffuse from employee to employee). The relationship between each node are shown in Figure.1

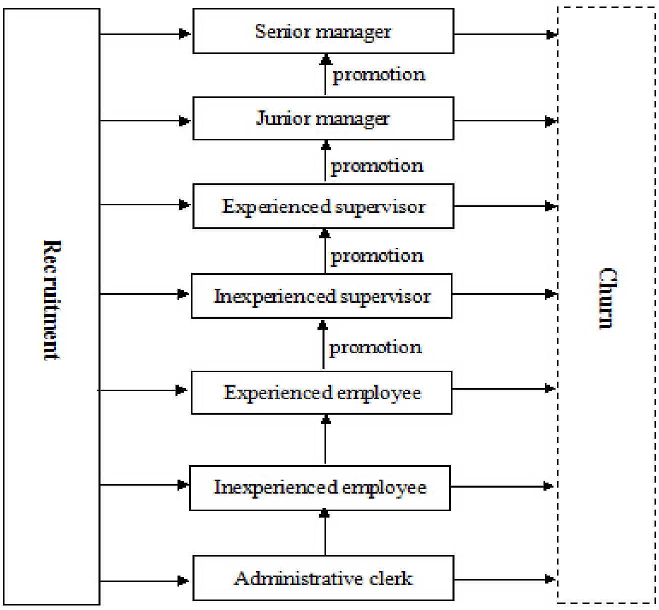

Fig.1 The Dynamic Network about Each Nodethe Churn of Rate for Each Position is Defined as

$$Rc = \frac{The\ number\ of\ churn}{The\ number\ of\ initial\ state}.$$

b. The probability of churning about everyone is defined as

$p_{ij} = a\ random\ number, 0 < p_{ij} < 1, j = 1, 2, \cdots, 370$.

c. The distance of $i-th$ level of position to the $j-th$ level of position is defined as d_{ij}. It is as shown in Table 2 (In order to convenient describe, we use LOP1 to replace senior manager/Executive, use LOP2 to behalf junior manager/Executive, use LOP3 to replace experienced supervisor (Branch), use LOP4 to represent inexperienced supervisor (Division), use LOP5 to replace experienced employee, use LOP6 to replace inexperienced employee, use LOP7 to replace administrative clerk)

d. The influence factor for the other employee of churn. Where, K_{factor} is a constant.

e. The impact on employee of churn for the others rate. $\Delta R = \frac{K_{factor}}{d_{ij}}$

Table 2 the Different Of Distance between Lop

d_{ij}	LOP1	LOP2	LOP3	LOP4	LOP5	LOP6	LOP7
LOP1	2	2	4	8	16	32	64
LOP2	2	2	2	4	8	16	32
LOP3	4	2	2	2	4	8	16
LOP4	8	4	2	2	2	4	8
LOP5	16	8	4	2	2	2	4
LOP6	32	16	8	4	2	2	2
LOP7	64	32	16	8	4	2	2

f. The cost of recruit, $Cr = N_{recruit} \times Median\ \ \cos t\ \ of\ \ recruitmen$

g. The cost of train, $Ct = N_{recruit} \times average\ annual\ training\ \ \cos t \times time$

h. The frequency of recruit for each position is shown in the follow Tablele.

Different level of position have different the number of employees at this level. This situation is shown in Table 3

Table 3 on the Number of Staff and Position

Level of position	Number of employees at this level
LOP1	10
LOP2	20
LOP3	25
LOP4	25
LOP5	110
LOP6	150
LOP7	30

The number of each level of position is not fixed. Because these positions can be involve in churning, recruiting and promoting. In order to simplify the calculate, we use the digital 1 to represent full status for position, use the digital 0 to behalf the vacancy status for position. The changes of dynamic have several conditions. It is shown as the following Table 4

Table 4 the Situation About the Dynamic Changes

dynamic changes	Explanation
1 → 1	Worker neither to promote nor churn
0 → 0	Neither to recruit a staff nor promote a staff
1 → 0	Workers churning or promote a higher position
0 → 1	Recruit a staff or promotion a position through the lower status

3. The Implementation of the Dynamic Network Model

In the dynamic network, each node is stored in matrix $A_i = \left[a_{i,j} \right]_{1\times 370}$, the $j-th$ row of A is a row vector.

Where, the element of A is a 0-1 variable.

$$a_{ij} = \begin{cases} 0, & full\ status\ for\ positions \\ 1, & vacancy\ status\ for\ positions \end{cases}$$

The relationship between $a_{i+1,j}$ and a_{ij} are as follows,

(1) The staff of churn.

$$a_{i+1,j} = \begin{cases} a_{ij},\ a_{ij} = 0, \\ a_{ij} + Ic_j,\ a_{ij} = 1. \end{cases}$$

$$Ic_j = \begin{cases} 0,\ p_{ij} < 1 - Rc_j, \\ -1,\ p_{ij} \ge 1 - Rc_j. \end{cases}$$

The influence by each other, churn is diffuse from employee to employee, it caused the rate of churn more and more large, the detail formula is as follow,

$$Rc(j+1) = Rc(j) + \frac{K_{factor}}{d_{ij}}$$

(2)Recruitment

$$a_{i+1,j} = \begin{cases} a_{ij},\ a_{ij} = 1, \\ a_{ij} + Ir_j,\ a_{ij} = 0. \end{cases}$$

$$Ir_j = \begin{cases} 0,\ not\ recuiting, \\ 1,\ recuit. \end{cases}$$

(3)Internal flow (promotion)

$$a_{i+1,j} = \begin{cases} a_{ij},\ not\ promotion, \\ a_{ij} + 1,\ promotion. \end{cases}$$

$$a_{i+1,j+N} = \begin{cases} a_{ij},\ not\ promotion, \\ a_{ij} - 1,\ promotion. \end{cases}$$

Using the simulation of 2000 times, to discuss the rate of position to simulation for each one, the rate of churn, the number of recruit and the number of each position in the next 2 years, respectively. The result is shown in the following Figureure2.

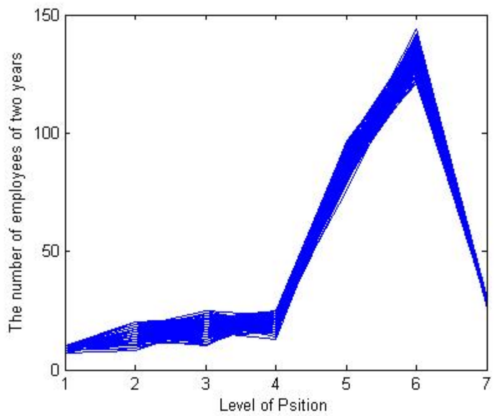

Fig.2 Simulation the Number of Staff for Each Position in the Next 2 Years

In order to research direct and indirect effects on the organization's productivity, we define productivity as follow

$$F_t = \frac{\sum_{j=1}^{370} a_{ij} S_j}{S_{\Sigma}}.$$

According to the task, it required to budget the cost of recruiting and train in the next 2 years. Using the way of Monte Carlo simulation, the results are as shown in Table 5. This Tablele show that the cost of calculate recruiting and coach for each month, each position in the next 2 years.

Table 5 the Cost Of Recruiting and Train in the Next 2 Years

Each department two years of recruitment cost							Each department two years training costs							Total
LOP1	LOP2	LOP3	LOP4	LOP5	LOP6	LOP7	LOP1	LOP2	LOP3	LOP4	LOP5	LOP6	LOP7	
0	0	0.6	0	0	0.1	0.3	0	0	0.0167	0	0	0.025	0.0042	1.0458
0	0	0	0.6	0.3	0.1	0	0	0	0	0.025	0.0083	0.025	0	1.0583
1.2	0	0	0	0	0.1	0	0.0417	0	0	0	0	0.025	0	1.3667
0	0	0	0	0	0.1	0	0	0	0	0	0	0.025	0	0.125
0	0	0	0	0.3	0.1	0.3	0	0	0	0	0.0083	0.025	0.0042	0.7375
0	0	0	0	0.3	0.1	0	0	0	0	0	0.0083	0.025	0	0.4333
0	0	0	0	0	0.1	0	0	0	0	0	0	0.025	0	0.125
0	0	0	0	0.3	0.1	0	0	0	0	0	0.0083	0.025	0	0.4333
0	0	0	0	0.3	0.1	0.3	0	0	0	0	0.0083	0.025	0.0042	0.7375
0	0	0	0	0.3	0.1	0	0	0	0	0	0.0083	0.025	0	0.4333
0	0	0.6	0	0.3	0.1	0.3	0	0	0.0167	0	0.0083	0.025	0.0042	1.3542
0	0	0	0	0	0.1	0	0	0	0	0	0	0.025	0	0.125
0	0	0	0	0	0.1	0	0	0	0	0	0	0.025	0	0.125
0	0	0	0.6	0	0.1	0	0	0	0	0.025	0	0.025	0	0.75
1.2	0	0.6	0	0	0.1	0	0.0417	0	0.0167	0	0	0.025	0	1.9833
0	0	0.6	0	0	0.1	0	0	0	0.0167	0	0	0.025	0	0.7417
0	0.7	0	0	0	0.1	0.3	0	0.05	0	0	0	0.025	0.0042	1.1792
0	0	0	0	0.3	0.1	0.3	0	0	0	0	0.0083	0.025	0.0042	0.7375
0	0	0	0	0	0.1	0.3	0	0	0	0	0	0.025	0.0042	0.4292
0	0	0	0	0	0.1	0	0	0	0	0	0	0.025	0	0.125
0	0	0	0	0	0.1	0	0	0	0	0	0	0.025	0	0.125
0	0.7	0	0.6	0	0.1	0	0	0.05	0	0.02	0	0.02	0	1.5

										5		5		
0	0	0	0	0	0.1	0	0	0	0	0	0	0.02 5	0	0.125
0	0	0.6	0	0.3	0.1	0	0	0	0.016 7	0	0.008 3	0.02 5	0	1.05

4. Conclusion

This paper constructs a human capital network. Based on this network, a dynamic model is established to describe the external turnover, internal promotion and recruitment of employees, that is, to simulate the process of employee turnover, recruitment and internal flow. The specific algorithm steps are given, and the company's human capital allocation strategy based on optimization is given. This work can help enterprises and organizations better understand the internal staff turnover and optimize their management strategies and business plans. However, this paper does not involve the complex human capital network model of multiple companies, which will become the focus of future research.

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