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The Manpower Planning Model for Optimizing Human Resource Based on Flow Cost

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Abstract: Based on traditional human resource programming model,we improve the model in this paper by taking the flow of different staffs in the same class into account and construct a model for optimizing human resource flow cost.The model proves that when the demand of enterprise is meet ,we can reduce the flow cost through adjusting the flow strategy of employees in the same class. Eventually, we use a numerical example analysis by lingo,proving that the model is indeed effective on optimizing the flow cost.

Keywords Modeling; Markov; Manpower planning; Cost optimization; Human resource flow cost

INTRODUCTION

There are two main channels to meet the lack of employees: internal promotion and external recruitment. How to balance the number of staffs for promotion and recruitment is considerable for the management. Markov chain model is a traditional tool usually used to describe the behavior of a manpower structure. The current study, however, tend to assume that the internal flow between staffs only conclude promotion , ignoring the fact that staffs in the same class also flow among each other ,in order to meet the needs of manpower. Therefore, in this paper we proposed a improved model by taking flow in the same class into account. In order to make it more utility, we construct a model to optimize the flow cost, not only can reduce the flow cost, but can offer guidance for hiring and promotion.

THEORY FOR MANPOWER FLOW COST

We adopted the human resource cost calculation method mentioned in the book “Human Resource Accounting” [Zhongwen Liu, 2006]by professor Zhongwen Liu. He divided the human resource cost into five parts: acquisition cost, development cost, the use of cost, insurance cost, departure cost and replacement cost according to the process that human resource flow occurs. Among this costs, there are three parts caused by move of staffs: acquisition cost, development cost and dimission cost. The acquisition cost consists the cost of recruitment, selection, hiring and rehousing. Human resource development costs can be divided into direct and indirect costs of training. The direct costs refer to the fee caused by direct training. The indirect parts conclude all opportunity costs related with the activities of the relevant personnel. In this paper, we ignore the indirect costs, we only consider the direct training cost for promotion. Dimission cost means the loss that caused by employ turnover. It mainly consists of wages, compensation, management cost, efficiency loss before leave, job vacancy loss and so on.

The human resource flow cost mentioned in this paper includes three parts: Acquisition cost, staff training cost (ignoring indirect development costs) and dimission cost, which three are all caused by employee turnover.

THE OPTIMIZATION MODEL FOR MANPOWER FLOW COST

Assumption

1.Assume the number of employees needed for each position in the future year is available.

2.Assume that employees can be equal to any other positions of the same class without training.

3.Staffs can be elevated to a position of one-higher class after training but cannot move to a two-class higher position. Also, we assume employees of senior class won't move to lower classes [Beibei Shi, 2012].

4.The number of the employees leave office in the next year can be predicted according to historical data.

5.Assume the staff who is promoted must be trained, but those not have had no training class.

6.Assume employees from external recruitment don't have to be trained except junior staffs, those middle and senior managements are enough competent for the new job.

7.Assume that in order to maintain the stability of company, the stability factor of each position mustn’ be lower than it’s specific value.

8.In order to keep the vitality of the company's personnel, the proportion of external recruitment had better be higher than a certain value.

Parameters Definition

Assume that the population of the manpower system is stratified into R classes denoted by the set S={1,2,...r} which represent the r hierarchical states

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of the system. The number of posts in each state is denoted by *k(r)* .So, number the post of all states by the set S’ =$\{1^1,1^2,...1^{k(1)},2^1,2^2,..2^{k(2)}...r^{k(r)}\}$[Dimitriou *et al.*,2010].

Let p_{ij} denote the transition probability of the employees.

$$i=1^1,1^2...1^{k(1)},2^1...2^{k(2)}...r^1...r^{k(r)};$$
$$j=1^1,1^2...1^{k(1)},2^1...2^{k(2)}...r^1...r^{k(r)};$$

$\boldsymbol{M_i}$: instead the existing number of employees for any time t.

$\boldsymbol{D_i}$: denote the needed employees of post *j* for any time t+1.

$\boldsymbol{S_i}$: represent the number of employees that recruit from external system.

$\boldsymbol{L_i}$: instead the average number of departure

$\boldsymbol{A_i}$: denote the average acquisition cost

$\boldsymbol{b_i'}$: denote the average training cost of existing employees

$\boldsymbol{b_i'}$: instead the average training cost of employees that recruit from external system.

$\boldsymbol{c_i}$: instead the average departure cost

$\boldsymbol{u_i}$: denote the pass rate of the recruitment

$\boldsymbol{q_i}$: instead the Stability factor for each post.

$\boldsymbol{f_i}$: instead the least proportion that the recruitment occupies of the total employees.

The Optimization Model for Manpower Flow Cost

$$\min\left\{\sum_{j=1^1}^{r^{k(r)}}\frac{S_j(a_j+b_j')}{u_j}+\sum_{i=1^1}^{r^{k(r)}}M_ib_i'\sum_{j>i}^{r^{k(r)}}p_{ij}+\sum_{i=1^1}^{r^{k(r)}}L_ic_i\right\}$$

$$s.t\ \ M_i*\sum_{j=1^1}^{r^{k(r)}}p_{ij}+L_i=M_i \qquad (1)$$

$$\sum_{i=1^1}^{r^{k(r)}}M_i*p_{ij}+S_j=D_j \qquad (2)$$

$$S_j\ge D_j*f_j \qquad (3)$$

$$p_{ii}\ge q_i \qquad (4)$$

$$i=1^1,1^2...1^{k(1)},2^1...2^{k(2)}...r^1...r^{k(r)}$$
$$j=1^1,1^2...1^{k(1)},2^1...2^{k(2)}...r^1...r^{k(r)}$$

Formula(1)describes the behavior of existing employees.

Formula (2) meets the demand of each position in the following year.

Formula (3) provides the limit for the recruitment.

Formula (4) limits the stability rate for each post.

Calculation

The hierarchy of company A is three, *k(1)=9, k(2)=5, k(3)=3,* so the model of manpower flow cost of company A is as follows:

$$\min\left\{\sum_{j=1^1}^{3^3}\frac{S_j(a_j+b_j')}{u_j}+\sum_{i=1^1}^{3^3}M_ib_i'\sum_{j=1^1}^{3^3}p_{ij}+\sum_{i=1^1}^{3^3}L_ic_i\right\}$$

$$s.t\ \ M_i*\sum_{j=1^1}^{3^3}p_{ij}+L_i=M_i \qquad (1)$$

$$\sum_{i=1^1}^{3^3}M_i*p_{ij}+S_j=D_j \qquad (2)$$

$$S_j\ge D_j*f_j \qquad (3)$$

$$p_{ii}\ge q_i \qquad (4)$$

$$i=1^1,1^2...1^9,2^1...2^5,3^1,3^2,3^3$$

$$j=1^1,1^2...1^9,2^1...2^5,3^1,3^2,3^3$$

The human resource data is showed in Table 1.

Table 1. Human resource data of company A

	$\boldsymbol{M_i}$	$\boldsymbol{D_j}$	$\boldsymbol{q_i}$	$\boldsymbol{f_j}$	$\boldsymbol{L_i}$	$\boldsymbol{a_j}$	$\boldsymbol{b_i'}$	$\boldsymbol{b_j'}$	$\boldsymbol{c_i}$	$\boldsymbol{u_j}$
$\boldsymbol{i=1^1}$	300	357	0.5	0.2	24	100	50	20	40	0.7
$\boldsymbol{i=1^2}$	400	454	0.5	0.2	32	100	50	20	40	0.7
$\boldsymbol{i=1^3}$	280	326	0.5	0.2	26	100	50	20	40	0.7
$\boldsymbol{i=1^4}$	360	408	0.5	0.2	42	100	50	20	40	0.7
$\boldsymbol{i=1^5}$	420	484	0.5	0.2	39	120	70	40	40	0.6
$\boldsymbol{i=1^6}$	180	204	0.5	0.2	21	120	70	40	40	0.6
$\boldsymbol{i=1^7}$	210	238	0.5	0.2	25	120	70	40	40	0.6
$\boldsymbol{i=1^8}$	230	256	0.5	0.2	28	150	90	60	40	0.5
$\boldsymbol{i=1^9}$	380	428	0.5	0.2	38	150	90	60	40	0.5
$\boldsymbol{i=2^1}$	86	105	0.6	0.1	12	200	120	0	60	0.4
$\boldsymbol{i=2^2}$	94	115	0.6	0.1	15	200	120	0	60	0.4
$\boldsymbol{i=2^3}$	68	84	0.6	0.1	12	250	140	0	60	0.3
$\boldsymbol{i=2^4}$	105	133	0.6	0.1	20	250	140	0	60	0.3
$\boldsymbol{i=2^5}$	74	88	0.6	0.1	16	300	160	0	60	0.3
$\boldsymbol{i=3^1}$	39	48	0.7	0.05	7	400	0	0	100	0.2
$\boldsymbol{i=3^2}$	28	34	0.7	0.05	5	400	0	0	100	0.2
$\boldsymbol{i=3^3}$	42	52	0.7	0.05	9	500	0	0	100	0.2

Because employees cannot turnover across two hierarchies and the senior staff won't move to lower classes. So the Markov chain that represented the personnel transition probability matrix can be expressed as Table 2.

Table 2. Markov transition probability of employees

p_{ij}	$j=1^1$	$j=1^2$	$j=1^3$	$j=1^4$	$j=1^5$	$j=1^6$	$j=1^7$	$j=1^8$	$j=1^9$	$j=2^1$	$j=2^2$	$j=2^3$	$j=2^4$	$j=2^5$	$j=3^1$	$j=3^2$	$j=3^3$
$i=1^1$															0	0	0
$i=1^2$															0	0	0
$i=1^3$															0	0	0
$i=1^4$															0	0	0
$i=1^5$															0	0	0
$i=1^7$															0	0	0
$i=1^8$															0	0	0
$i=1^9$															0	0	0
$i=2^1$	0	0	0	0	0	0	0	0	0								
$i=2^2$	0	0	0	0	0	0	0	0	0								
$i=2^3$	0	0	0	0	0	0	0	0	0								
$i=2^4$	0	0	0	0	0	0	0	0	0								
$i=2^5$	0	0	0	0	0	0	0	0	0								
$i=3^1$	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
$i=3^2$	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
$i=3^3$	0	0	0	0	0	0	0	0	0	0	0	0	0	0			

There is some difficulty in the formula to convey directions the employees flow to ,which was mentioned in assumption 3.We assign the training cost a great value (10,000) to avoid the two conditions .So the training cost spent on the employees is as Table 3.

Table 3. The training cost of company A

$b_{j'}$	$j=1^1$	$j=1^2$	$j=1^3$	$j=1^4$	$j=1^5$	$j=1^6$	$j=1^7$	$j=1^8$	$j=1^9$	$j=2^1$	$j=2^2$	$j=2^3$	$j=2^4$	$j=2^5$	$j=3^1$	$j=3^2$	$j=3^3$
$i=1^1$	0	0	0	0	0	0	0	0	0	50	50	50	50	50	10000	10000	10000
$i=1^2$	0	0	0	0	0	0	0	0	0	50	50	50	50	50	10000	10000	10000
$i=1^3$	0	0	0	0	0	0	0	0	0	50	50	50	50	50	10000	10000	10000
$i=1^4$	0	0	0	0	0	0	0	0	0	50	50	50	50	50	10000	10000	10000
$i=1^5$	0	0	0	0	0	0	0	0	0	70	70	70	70	70	10000	10000	10000
$i=1^6$	0	0	0	0	0	0	0	0	0	70	70	70	70	70	10000	10000	10000
$i=1^7$	0	0	0	0	0	0	0	0	0	70	70	70	70	70	10000	10000	10000
$i=1^8$	0	0	0	0	0	0	0	0	0	90	90	90	90	90	10000	10000	10000
$i=1^9$	0	0	0	0	0	0	0	0	0	90	90	90	90	90	10000	10000	10000
$i=2^1$	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0	0	0	120	120	120
$i=2^2$	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0	0	0	120	120	120
$i=2^3$	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0	0	0	140	140	140
$i=2^4$	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0	0	0	140	140	140
$i=2^5$	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0	0	0	160	160	160
$i=3^1$	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0
$i=3^2$	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0
$i=3^3$	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	0	0	0

Use Lingo to compute this model, we can work out the transition probability matrix of the employees in Table4, the number of flow employees andrecruitment in Table5.

We can work out the total flow cost is 280,743.8.

Table 4. The transition probability matrix of the employees

p_{ij}	$j=1^1$	$j=1^2$	$j=1^3$	$j=1^4$	$j=1^5$	$j=1^6$	$j=1^7$	$j=1^8$	$j=1^9$	$j=2^1$	$j=2^2$	$j=2^3$	$j=2^4$	$j=2^5$	$j=3^1$	$j=3^2$
$i=1^1$	0.5						0.06	0.3								
$i=1^2$		0.87	0.06													
$i=1^3$			0.5				0.11				0.09	0.2				
$i=1^4$				0.5					0.23	0.08			0.04			
$i=1^5$					0.86	0.05										
$i=1^6$						0.5			0.38							
$i=1^7$			0.25		0.13		0.5									
$i=1^8$						0.23	0.15	0.5								
$i=1^9$	0.36	0.04							0.5							
$i=2^1$										0.6	0.08			0.11	0.07	
$i=2^2$											0.6				0.07	0.17
$i=2^3$										0.22						
$i=2^4$												0.6	0.21			
$i=2^5$											0.18		0.6			
$i=3^1$														0.82		
$i=3^2$														0.12	0.7	
$i=3^3$																0.79

Table 5. The number of flow employees and recruitment

p_{ij}	$j=1^1$	$j=1^2$	$j=1^3$	$j=1^4$	$j=1^5$	$j=1^6$	$j=1^7$	$j=1^8$	$j=1^9$	$j=2^1$	$j=2^2$	$j=2^3$	$j=2^4$	$j=2^5$	$j=3^1$	$j=3^2$	$j=3^3$	L_j	D_j
S_j	72	91	111	228	97	41	48	52	86	11	12	9	14	9	3	2	3		889
$i=1^1$	150						18	89				19						24	300
$i=1^2$		346	22															32	400
$i=1^3$			140				32				26		56					26	280
$i=1^4$				180					83	27		15		13				42	360
$i=1^5$					360	21												39	420
$i=1^6$						90			69									21	180
$i=1^7$			53		27		105											25	210
$i=1^8$						52	35	115										28	230
$i=1^9$	135	17							190									38	380
$i=2^1$										52	7				10	6		12	86
$i=2^2$											56					7	16	15	94
$i=2^3$										15		41						12	68
$i=2^4$													63	22				20	105
$i=2^5$											14			44				16	74
$i=3^1$															32			7	39
$i=3^2$															3	20		5	28
$i=3^3$																	33	9	42
M_i	357	454	326	408	484	204	238	256	428	105	115	84	133	88	48	34	52		

If we don't consider the flow of staffs in same class, we can know the hierarchy of company A is

k=1,2,3.The human resource flow cost model is as follow:

$$s.t \quad M_i * \sum_{j=1}^{3} p_{ij} + L_i = M_i \qquad (1)$$

$$\sum_{i=1}^{3} M_i * p_{ij} + S_j = D_j \qquad (2)$$

$$S_j \ge D_j * f_j \qquad (3)$$

$$p_{ii} \ge q_i \qquad (4)$$

$$i = 1,2,3$$
$$j = 1,2,3$$

We can gain the human resource flow cost C=379,303.4.It is much more than 280,743.8.

CONCLUSION

The traditional manpower planning model always assume employees flow among different classes ,but in fact in some companies staffs also flow in the same class. We take this situation into account and construct a new manpower planning model. In order to make this model more practical, we use the human resource flow cost as a goal to balance the behavior of promotion, recruitment and training. It is practical and has economic significance.

The are some shortages of this model. We don't limit the conditions when staffs move to lower states or have a promotion to two-class higher positions inthe model, though we can avoid this problem when calculating .In the future research, we will improve it through redefining parameters, making it more comprehensive.

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