2011 International Conference on Modeling, Simulation and Control
IPCSIT vol.10 (2011) © (2011) IACSIT Press, Singapore

An Optimization Approach for Forecasting of Workers Intake

Junoh, A. K[1], Najah, G.[2] , Muhamad, W. Z. A. W.[3] , Shakir, N. A. A.[4] ,
Jaafar, W. N. W.[5] and Saad, S.[6]

Institute of Engineering Mathematics
Universiti Malaysia Perlis, Kuala Perlis, Malaysia
[1]kadri@unimap.edu.my, [2]najahghazali@unimap.edu.my, [3]wanzuki@unimap.edu.my,
[4]nooradila@unimap.edu.my, [5]hadani@unimap.edu.my, [6]shakila@unimap.edu.my.

Abstract. In this paper, we develop a model for forecasting of permanent, contract and temporary workers intake in government sector. By comparing to existing allocation worker methods, this paper proposed optional method by using linear programming approach to determine the optimal number of workers that should be hired. Study show that the costs to hire contract and temporary workers compared to bring on full-time workers are same or just slightly less. However, in previous research, there is no particular way to determine the quota of workers' appointment and the current system fully depends on the available vacancies to hire worker. According to this situation, a lot of temporary and contract worker missed to be absorbed into permanent status due to strong competition with the future permanent worker. Other point highlighted is the study also took into account contract workers that been converted into permanent status when they are working more than certain period.

Keywords: Linear programming, allocation worker, trend, modelling

1. Introduction

Basically this study is conducted to develop a model to allocate the number of supporting staffs that required in particular years for management planning purpose. The scope of the study is the allocation of workers for supporting staff at Universiti Malaysia Perlis (UniMAP). Generally, at UniMAP, staffs who been hired can be divided into two categories, a) academic and professional b) supporting staff. In this study, we just focus on the intake of supporting staff, since we think that the cost for hiring supporting staffs quite high and suppose to be more efficient. The new staff intake requires the management of human resource department (HRD) to be more efficient and smart to estimate the number of supporting staffs, since the management do not able to hold high burden in terms of salaries aspect. However, the management of UniMAP still have to hire new staff according to the demand from the department in UniMAP. Currently there is no particular method which able to estimate the allocation of workers by considering the intake of contract, temporary and permanent workers. In order to solve this problem through this study, we will propose one specific method to allocate the number of workers for supporting staff in particular years as an estimation of new workers intake in quota pattern.

2. Research Background

Nakade and Nishiwaki (2006) have discussed the optimization problem to find the allocation workers at the manufacturing line that minimizes the overall cycle time under the minimum number of workers to satisfy the demand. In their study, they set the workers to be placed in U-shaped production line with automated processing. Miltenburg and Wijngaard (1994) also discussed the line balancing problem of the U-shaped line with constant operation times, no waiting times and no walking times. They have considered the optimal machine allocation problem to workers, which they called stations, under the precedence constraints.

Continue to that, Nakade and Ohno (1999) show the algorithm for optimal allocation of homogenous workers, further consideration and development to find optimal allocation of heterogeneous workers that are needed because the formulation of the problem must be changed and the number of possible allocations of workers extremely increases, which leads to the huge increase of the amount of necessary memories and running times for computing. In other case, Shamsul Bahar and Kawata, (1996) discussed the problem of workers placement in industrial environment. In order to help the decision makers (DMs) to select the better workers, the evaluation of workers under the various evaluation criteria is very important (Duffuaa & Raouf, 1992; Liang & Wang, 1992). According to that, the purpose of this research is to help the DMs to select the various candidates effectively (Bellman & Zadeh, 1970). For this type of problem, they use an analysis of fuzzy number approach.

Niemi (2009) claimed that assembly in the make-to-order manufacturing of large variable products is usually organized as a cell in which team of workers operate with. He concerned the due dates and workforce efficiency to optimize the allocation of workers to the products, so that the timing constraint are met, while the labor cost are minimized by using mixed integer linear programming model. Research done by Nico et al (2010) under budget allocation for permanent and contingent capacity have shown that the capacity can be minimized under the assumption of restricted budget. There are also study done by Michael (2000) where he introduce new and generally applicable definitions of economies of scale and scope and illustrate them by means of entended numerical examples. In expenditure process, workers are the most important input to produce services and goods. Moreover, workforce will be generated with current modals to get the output. Research done by Ghosh and Neogi (1996) have shown that worker from private sector are more qualified and more efficient than the workers from the government sector in India whereas Nor Ghani and Zulkefly (2007) prove the government worker are more efficient than private sector in certain factor. So we hope that we can be part of the group that can produce a better way of suggesting new model in allocation for temporary workers in government sector.

2.1. Linear Programming

Since the study focus on the linear trends which based on the previous year data of workers intake, the optimization method which will be applied in this study is Linear Programming (LP). LP is a branch of mathematical programming. It is a mathematical method for determining a way to achieve the best outcome (such as maximum profit or lowest cost) in a given mathematical model for some list of requirements represented as linear relationships. What makes it linear is that all constraints are linear inequalities in the variables. In addition, objective function is also linear. Things like requiring $xy \geq 100$ are not allowed, since this wouldn't be a linear inequality. The general process for solving linear-programming problems is to graph the inequalities (called the constraints) to form a walled-off area on the x,y-plane (called the feasibility region). Then coordinates of the corners of this feasibility region is determined by finding the intersection points of the various pairs of lines, and test these corner points in the formula as optimization equation depending on the objective function whether to find the highest or lowest value.

3. Research Methodology

Basically to develop the allocation worker model, the status of the worker must be clarified. Generally in UniMAP the status of the worker of supporting staff can be divided into three types: a) permanent, b) contract and c) temporary workers. The classification about these three statuses can be referred as follow:-

- Permanent - Every workers who hired are depending on the vacancy which available in organization. The worker will be paid with salary and allowances. The duration of the service is until the date of retirement.
- Contract - Every workers hired depending on the demand of the department at particular time. The workers also will be paid salary and allowances same as permanent worker. However, normally the duration of the service will be renewed over two years.
- Temporary - Every workers hired will be paid with wages follow to the working hours and need to complete and sign the contract agreement. The agreement can be amended by head of department depend on the suitability of the duty which required.

In order to develop optimization model, the trend of the intake of supporting staff must be identified. The changes number of workers will be studied against the changes of the years. After the trend obtained then the equations to represent the actual trend will be formulated and used in mathematical model. Here, as mathematical model tools we use linear programming approach. Through this model we will be able to predict and estimate the required number of workers for each status of supporting staffs in order to get the optimal allocation workers quota by considering the current intake trend. As study algorithm, we represent the steps of the study followed by the Fig. 1.

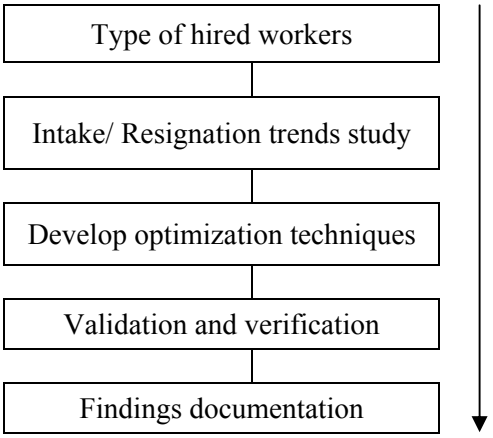


Fig. 1. Optimization Steps of Algorithm

In this study, to identify the trends of the intake and resignation we basically use the data which provided by HRD from year 2002-2007. Within that period, the intake or resignation trends will be formulated as equations which will be used in our optimization model. The data of the year 2002-2007 are given by the following Table 1 and Table 2 (Fig. 2).

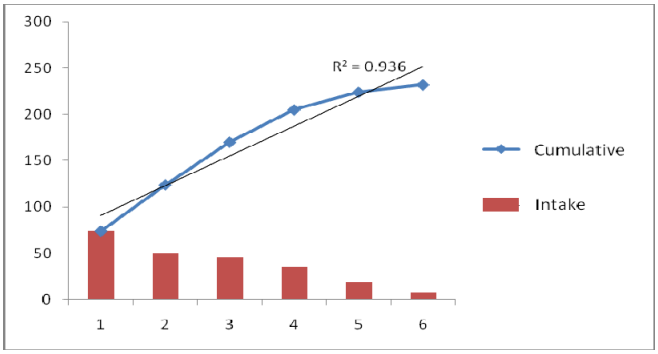
Table 1: Intake Data for Supporting Staffs

	2002		2003		2004		2005		2006		2007	
	Intake	Cum	Intake	Cum	Intake	Cum	Intake	Cum	Intake	Cum	Intake	Cum
Support	147	147	105	252	149	401	142	543	126	669	228	897
Permanent	74	74	50	124	46	170	35	205	19	224	8	232
Contract	32	32	23	55	54	109	61	170	63	233	132	365
Temporary	4	4	1	5	12	17	6	23	8	31	27	58
CTP	45	45	43	88	54	142	58	200	52	252	78	330

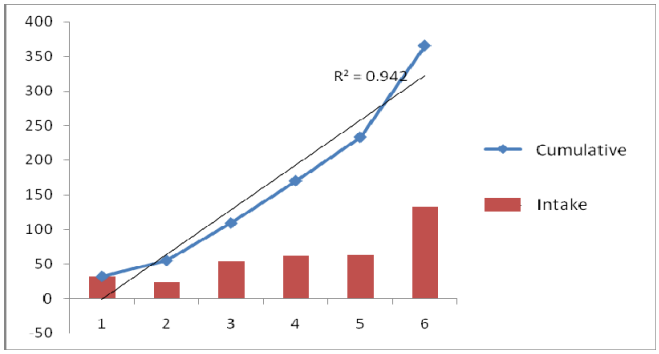
Note : CTP- converted to permanent, cum- cumulative

Table 2 : Resignation Data for Supporting Staffs

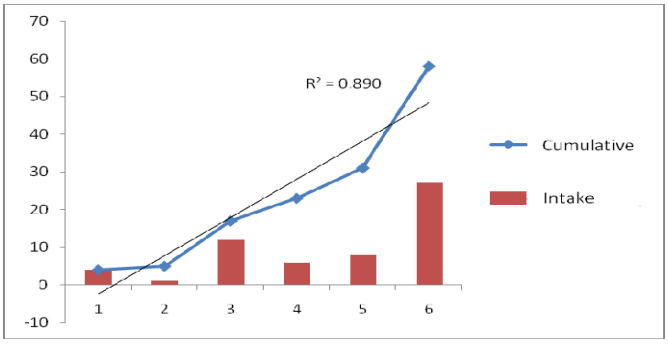
	2002	2003	2004	2005	2006	2007
Resignation	8	12	17	18	16	17
Cumulative	8	20	37	55	71	88



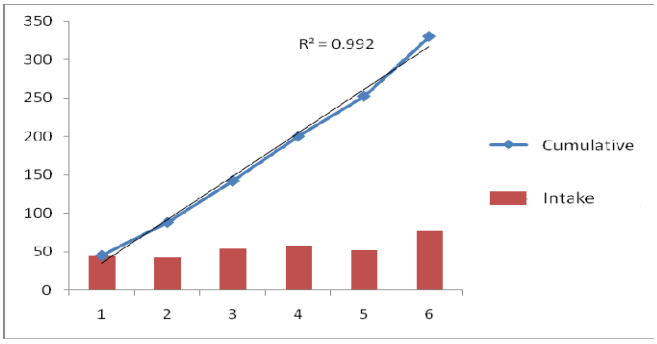
Permanent post



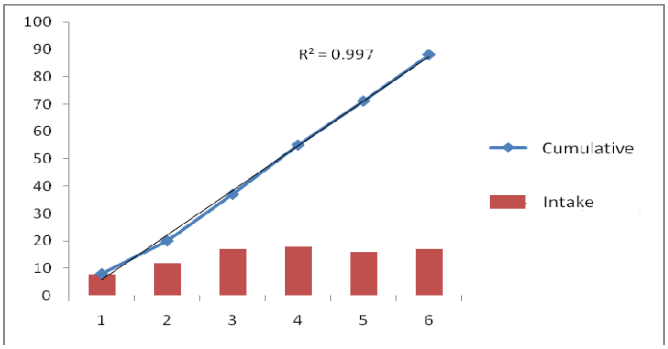
Contract post



Temporary post



Convert to permanent



Resignation/ Retirement

Fig. 2 : Intake and resignation trends

4. Modeling

In this optimization process we are targeting to estimate the number of intake of supporting staff based on trends which shown by the data from the previous years (year 1 until year 6). Thus, the forecasted number of intake only can be used to refer the number of intake for the year 7 and above. Based on the actual scenario, UniMAP is a university which just established on 2002. The trends represented by the graph (Fig. 2) show the intake number from year one to year six were increasing rapidly in order to fulfill the demand from new departments. However, lately started from year seven almost all of the departments have been founded and the demands from the departments are decreasing slowly. The objective of the model is we aim to maximize the intake of contract and temporary worker by minimizing the intake of permanent worker. Hence, the objective function is to maximize the number of contract and temporary worker who converted to permanent worker.

$$\text{Max } P'_{total}$$

The purpose of this model is to make estimation on the allocation of the supporting staff from year seven and above.

$$y = k \ \ (k = 7,8,9,...)$$

Some constraints were added in the model to reduce the intake of permanent worker due to budget constraints. For model building, we are assuming the variables to represent the number of each type of workers that can be referred as follows:

P_{total} : Cumulative number of permanent worker

C_{total} : Cumulative number of contract workers

T_{total} : Cumulative number of temporary workers

P'_{total} : Cumulative number of contract and temporary converted to permanent worker

R_{total} : Cumulative number of resigned workers

There are a few equations and constraints that will be applied in the model. The equations basically came from the trends of the worker intake and resignation against the years. The trends of the total worker for permanent post (P_{total}), contract post (C_{total}), temporary post (T_{total}), converted to permanent post (P'_{total}), resigned (R_{total}), and current staff (S) can be represented follow to the Fig. 2. The obtained equations are

$$P_{total} = 32t + 59 \quad (1)$$

$$C_{total} = 65t - 65 \quad (2)$$

$$T_{total} = 10t - 12 \quad (3)$$

$$P'_{total} = 56t - 21 \quad (4)$$

$$R_{total} = 16.3t - 10.6 \quad (5)$$

Here for optimization, the model must satisfy a few constraints which determined by HRD. The constraints that will be used in the model are shown as follows:

- The numbers of worker that be converted to permanent must be greater than 10% but less than 90% of the total number of contract and temporary worker.

$$P'_{total} \geq 0.1(C_{total} + T_{total}) \quad (6)$$

$$P'_{total} \leq 0.9(C_{total} + T_{total}) \quad (7)$$

- The total number of permanent workers must be greater than 5% but cannot be more than 60% of the total number of current workers.

$$P_{total} \geq 0.05(S_{total}) \quad (8)$$

$$P_{total} \leq 0.6(S_{total}) \quad (9)$$

- The total number of contract and temporary workers must be more than 30% and must be less than 70% of the total number of current workers.

$$C_{total} + T_{total} \geq 0.3(S_{total}) \quad (10)$$

$$C_{total} + T_{total} \leq 0.7(S_{total}) \quad (11)$$

- The total number of permanent workers must be greater than 10% and must be less than 50% of the total number of contract, temporary and converted to permanent workers.

$$P_{total} \geq 0.1(C_{total} + T_{total} + P'_{total}) \quad (12)$$

$$P_{total} \leq 0.5(C_{total} + T_{total} + P'_{total}) \quad (13)$$

Since the built model is designed to do forecasting on the allocation of the staff intake, the model modified the equations which obtained from (1) until (5) to follow suitability of the trends. Here, follow to HRD the intake of the staff must follow to fluctuation trends as shown as follows:

- The intake of the permanent workers must be in decreasing trend

$$P_{total} \leq 32t + 59 \tag{14}$$

- The intake of the contract and temporary workers must be in increasing trend

$$C_{total} \geq 65t - 65 \tag{15}$$

$$T_{total} \geq 10t - 12 \tag{16}$$

- The number of the staff who converted to permanent workers must be in decreasing trend

$$P'_{total} \leq 56t - 21 \tag{17}$$

Beside the above equations and constraints, we add some additional constraints to let the number of total staff for each category more than the total number of previous year (year six).

$$P_{total} \geq 232$$
$$C_{total} \geq 365$$
$$T_{total} \geq 58$$
$$P'_{total} \geq 330$$
$$R_{total} \geq 88$$

Here the number of the results must be in integer form.

$$P_{total}, C_{total}, T_{total}, P'_{total} \text{ and } R_{total} = \text{Integer}$$

5. Results and Discussions

Table 5 shows the result of the optimization model. From the observation, forecasted intake workers extremely increase year by year. These scenario is caused by the optimization model is using the equation which formed based on the trends of the data of intake workers from 2002 to 2007. During that period the organization was still new since it just founded started from year 2002. Thus, the organization has to hire a lot of workers in order to fulfill the demand of the staff in various departments. During that period also the organization has to hire a lot of permanent workers. Since the allocation of supporting staff become more stable by year 7, the organization has to reduce the intake of supporting staff year by year due to salary burden constraints.

Follow to the trends of intake displayed by the Fig. 2 (model 1), the trend of permanent worker is decreasing. In our model, we have to reduce the intake of the permanent worker by changing the status of contract and temporary worker to be converted to permanent status.

Table 5 : Staff intake forecasting based on model 1 results

Year	PP		S		P		C		T		R	
	PP	intake	S	intake	P	intake	C	intake	T	intake	R	resign
1	45	-	147	-	74	-	32	-	4	-	8	-
2	88	14	252	105	124	50	55	23	5	1	20	12
3	142	18	401	149	170	46	109	54	17	12	37	17
4	200	30	543	142	205	35	170	61	23	6	55	18
5	252	47	669	126	224	19	233	63	31	8	71	16
6	330	106	897	228	232	8	365	132	58	27	88	17
7	371	139	1001	104	283	51	390	25	58	0	101	13

8	427	56	1148	147	315	32	455	65	68	10	117	16
9	483	56	1295	147	347	32	520	65	78	10	133	16
10	539	56	1442	147	379	32	585	65	88	10	149	16
11	595	56	1589	147	411	32	650	65	98	10	165	16
12	651	56	1736	147	443	32	715	65	108	10	181	16
13	707	56	1852	116	444	1	780	65	118	10	197	16
14	763	56	1967	115	444	0	845	65	128	10	213	16
15	819	56	2082	115	444	0	910	65	138	10	229	16

The purpose of this study is to allocate the intake workers by doing forecasting based on the trend which provided by the original data. Furthermore, the models are also able to make forecasting in the future intake of workers by creating new trends depending on the requirement by in charged department. Finally, we hope the provided model might be useful for those who want to make forecasting for intake worker in the future.

6. Acknowledgements

The authors would like to thank the Universiti Malaysia Perlis (UniMAP), Short Term Grant. (9001-00296)

7. References

[1] Ghosh, B. and Neogi C. (1996). Liberalization in India: Quality Differential between public and private employees. The developing economies XXXIV-1.

[2] Nico, D. Jully, J. and Gergely, M. (2010). Budget allocation for permanent and contingent capacity under stochastic demand. Int Journal of Producion Economics.

[3] Niemi, E. (2009). Worker allocation in make-to-order assembly cells.

[4] Miltenburg G. J., and Wijngaard, J. (1994). The U-line balancing problem. Management Science. 40, 1378-1388

[5] Nor G., and Zulkefly, A. K. (2007). Perbandingan Kualiti Buruh Awam dan swasta dalam sektor pembuatan Malaysia.

[6] Liang G. S. and Wang, M. J. J. (1992). Personnel placement in a fuzzy environment. Computational Operational Research, 107-121.

[7] Michael, J. R. (2000). The distribution problem, the more for less (nothing) paradox and economies of scale and scope. European Journal of Operational Research, 92-104.

[8] Nakade, K., and Nishiwaki, R. (2006). Optimal allocation of heterogeneous workers in a U-shaped production line.

[9] Nakade K., and Ohno, K. (1999). An optimal worker allocation problem for U-shaped production line. International Journal of Production Economics. 60-61, 353-358.

[10] Bellman R. E., and Zadeh, L. A. (1970). Decision making in fuzzy environment. Management Sci. 17, 141-164.

[11] Duffuaa S. O., and Raouf, A. (1992). A simulation model determining maintenance staffing in an industrial environment, Journal of Simulation. 59, 93-99.

[12] Shamsul Bahar Y., and Kawata, S. (1996). Workers' placement in an industrial environment.