Optimal assignment for tasks of available resources

Abdul Ameer A.H. Al-Ali [a], Asraa M. Hamdy [b]
[a] Department of Accounting, Al-Esraa University College, Baghdad / Iraq (ORCID: 0000-0002-8263-8096)
[b] Department of Accounting, Al-Esraa University College, Baghdad / Iraq (ORCID: 0000-0003-4070-5921)
Corresponding Author: Abdul Ameer A.H. Al-Ali email: abdalameer@esraa.edu.iq

Article History: Received: 10 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 28 April 2021

ABSTRACT. Assignment model is a way that contributes in achieving the perfect use of available resources, the goal of it is getting most profit or decreasing cost or time, many processes can be done such as (jobs, workers), in a way of distributing it to the available resources which only one process is specified to every type of facility (available resources like machines). In this research, there are two methods for solving the assignment model, by making questionnaire form for certain professors in the accounting deportment of Al-Esraa university college, the assignment model has been solved by using two algorithms and the results are equal.

Keywords: assignment model, minimal, matrix time, linear programming, graph theory, objective function, questionnaire

1. INTRODUCTION :

The assignment model is considered as special case of the linear programming problems, and includes a numerous possible solutions. We can use these special algorithms in many problems that need administrative decision for specializing group of people to do certain jobs, for example we get the most productive output from these people, or we get the job done in minimum time and best efficiency available, the basic formula for assigning and specializing problems is the presence of a number of people or a number of workers that will get the job done in the best possible way.

2. THEORETICAL FRAMEWORK:

We can represent the assignment model in the existence of numerous (n) different jobs (could be jobs, places, services, … etc.), symbolizing for job with (j) by using worker (could be employee, machine), does the job , which there is a number (m) of works, and the worker can do any job (j), and cost (or time) of doing the job will differ from one worker to another, there are many forms of assignment model: [1]

1- The objective function can be in minimization state, therefore we can specify certain workers to do certain job, and the time or cost required to do this job must be as minimum as possible.
2- The objective function can be in maximization state, in this case we specify one worker to do certain job to maximize the profit.
3- If the assignment model which represents time matrix or non-square time matrix, we must add dummy rows or dummy columns.
4- If the job is difficult to be done by a specific machine nor facility, we mark them.

assuming the (x_{ij}) is the number of units by assigning the persons (i^{th}) to do a job (j^{th}),[4]

$$X_{ij} = \begin{cases} 1 & \text{If (i) person is assigned to (j) job} \\ 0 & \text{If (i) person is not assigned to (j) job} \end{cases}$$

The objective function is:
Max or Min Z = $\sum_{i=1}^{m}\sum_{j=1}^{n} t_{ij}x_{ij}$
Subject to :

$$\sum_{j=1}^{n} x_{ij} = 1 \qquad i = 1,2,\dots,m$$
$$\sum_{i=1}^{m} x_{ij} = 1 \qquad j = 1,2,\dots,n$$

In the case of balancing , when the required tasks that need to be done equal number of workers that will do the tasks which means
$\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ij} = n = m$
In the case of unbalancing n ≠ m we can convert to the balancing state by adding an imaginary factor (or more) in case m < n , or adding a job (or more) in case m > n .

3. APPLIED FRAMEWORK:

For the implementation of assignment model, a questionnaire form has been used of six professors in the accounting department of Al-Esraa university college, to find out the specific time for each lecture preparation of six chosen subjects, and the time required for the preparation of each subject is given in the matrix time

Lectures	Jobs					
	J_1	J_2	J_3	J_4	J_5	J_6
L_1	2	3	2	6	3	3
L_2	4	5	3	4	4	3
L_3	4	5	4	3	3	3
L_4	2	3	3	4	3	3
L_5	4	4	5	4	5	5
L_6	3	4	3	4	3	3

3.1 First method: Algorithm to solve assignment method: [2]
By using this method we follow the next steps:

1- Subtract the smallest value of each row from the corresponding row.
2- Subtract the smallest value of each column from the corresponding column.
3- If the row has one zero only then specify it to the corresponding row and remove the corresponding row and column after distribution.
4- If the matrix has more than one zero then find the successor and compare to the highest value and specify the zero.
5- Do again (3), (4) and figure the optimal solution.

Step (1): Appling 1, 2 to obtain following matrix time

Lectures	Jobs					
	J_1	J_2	J_3	J_4	J_5	J_6
L_1	0	1	0	4	1	1
L_2	1	2	0	1	1	0
L_3	1	2	1	0	0	0
L_4	0	1	1	2	1	1
L_5	0	0	1	0	1	1
L_6	0	1	0	1	0	0

Notice the position of zero:

Row	Column
L_1	J_1 , J_3
L_2	J_3 , J_6
L_3	J_4 , J_5 , J_6
L_4	J_1
L_5	J_1 , J_2 , J_4
L_6	J_1 , J_3 , J_5 , J_6

Assign $L_4 \longrightarrow J_1 = 2$, and remove corresponding row and column of above matrix

Step (2): Reduced matrix time after row and column reduction

Lectures	Jobs				
	J_2	J_3	J_4	J_5	J_6
L_1	1	0	4	1	1
L_2	2	0	1	1	0
L_3	2	1	0	0	0
L_5	0	1	0	1	1
L_6	1	0	1	0	0

Notice the position of zero:

Row	Column
L_1	J_3
L_2	J_3 , J_6
L_3	J_4 , J_5 , J_6
L_5	J_2 , J_4
L_6	J_3 , J_5 , J_6

Assign $L_1 \longrightarrow J_3 = 2$, and remove corresponding row and column of the above matrix

Step (3): Reduced matrix time after row and column reduction

Lecturess	Jobs			
	J_2	J_4	J_5	J_6
L_2	2	1	1	0
L_3	2	0	0	0
L_5	0	0	1	1
L_6	1	1	0	0

Notice the position of zero:

Row	Column
L_2	J_6
L_3	J_4 , J_5 , J_6
L_5	J_2 , J_4
L_6	J_5 , J_6

Assign $L_2 \longrightarrow J_6 = 3$, and remove corresponding row and column of the above matrix time

Step (4): Reduced matrix time after row and column reduction

Lectures	Jobs		
	J_2	J_4	J_5
L_3	2	0	0
L_5	0	0	1
L_6	1	1	0

Notice the position of zero:

Row	Column
L_3	J_4 , J_5
L_5	J_2 , J_4
L_6	J_5

Assign $L_6 \longrightarrow J_5 = 3$, , and remove corresponding row and column of the above matrix time

Step (5): Reduced matrix time after row and column reduction

Lectures	Jobs	
	J_2	J_4
L_3	2	0
L_5	0	0

Assign $L_3 \longrightarrow J_4 = 3$ and $L_5 \longrightarrow J_2 = 4$

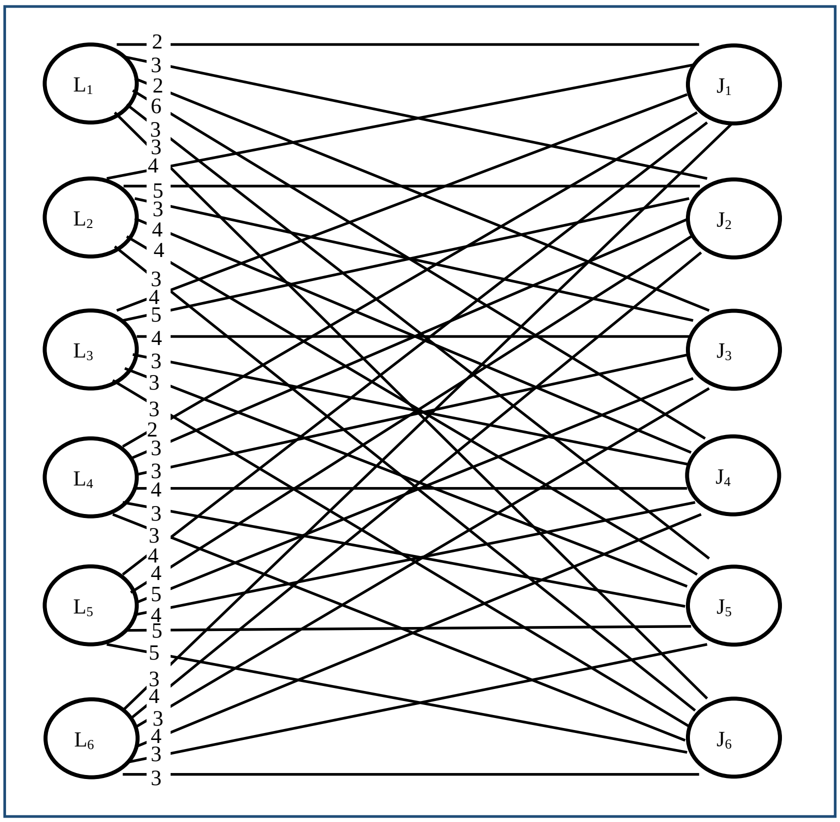
So the Minimal assignment time = $\sum_{i=1}^{m}\sum_{j=1}^{n} t_{ij}x_{ij}$ = 2 + 2 + 3 + 3 + 3 + 4 = 17

3.2 Second method: Algorithm to solve by proposed method [3]

This method solves the assignment model which is different from the first (preceding) method, which as follows:

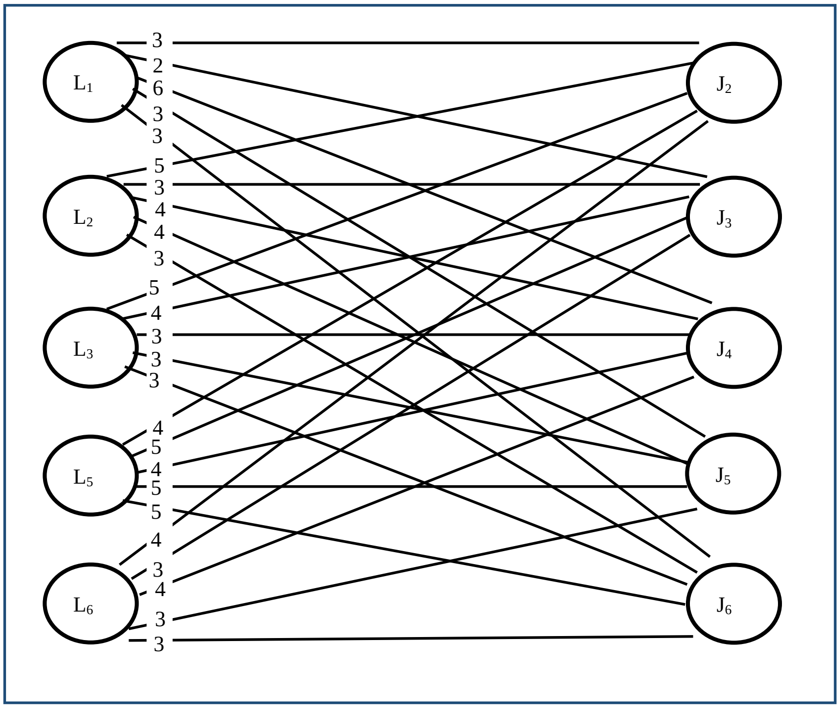
1- According to the general formulation of assignment model, we can modify the model into a graph theory.
2- The minimum time must be selected between the workers and the tasks.
3- Delete the selected edge with their nods.
4- Do again the prior steps to get each worker implemented with only one task.
5- Find the objective function.
6- When more than one edge occur which has the same time, we try to get numerous solutions and figure out the objective function for each solution and take the minimum value of the objective function.

Step (1):



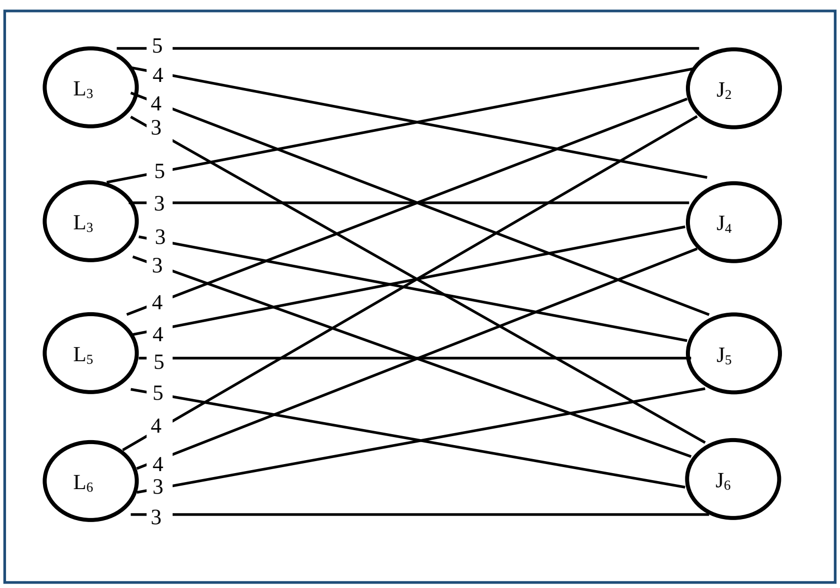
Min time $L_4 \longrightarrow J_1 = 2$, delete L_4 and J_1

Step (2):



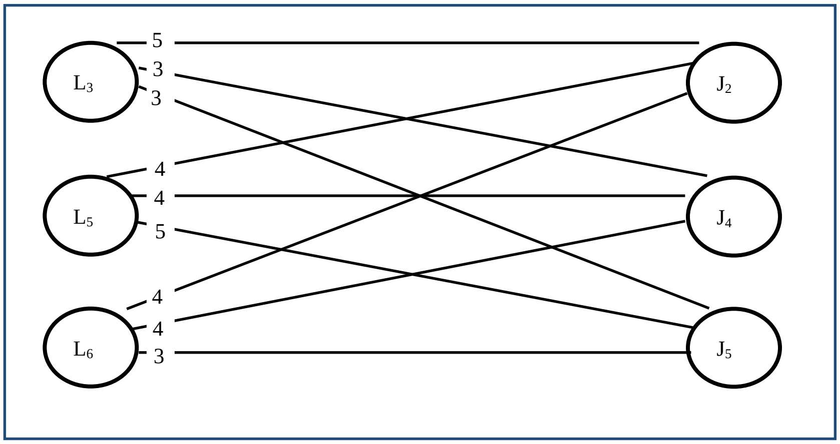
Min time $L_1 \longrightarrow J_3 = 2$, delete L_1 and J_3

Step (3):



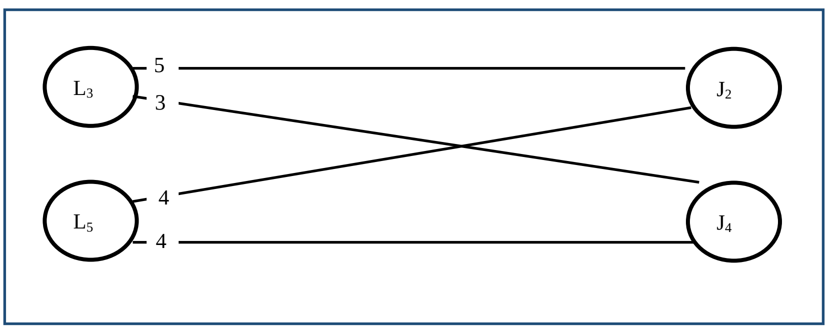
Min time $L_2 \longrightarrow J_6 = 3$, delete L_2 and J_6

Step (4):



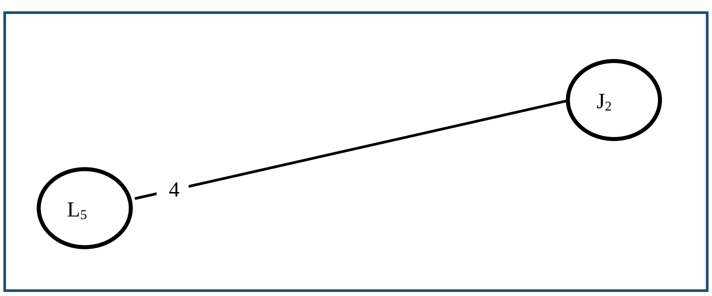
Min time $L_6 \longrightarrow J_5 = 3$, delete L_2 and J_6

Step (5):



Min time $L_3 \longrightarrow J_4 = 3$, , delete L_3 and J_4

Step (6):



Min time $L_5 \longrightarrow J_2 = 4$

Total minimum time is $\sum_{i=1}^{6}\sum_{j=1}^{6} t_{ij}x_{ij}$ = 2 + 2 + 3 + 3 + 3 + 4 = 17

4. COMPARISON:

problem	First method	Second method
Minimum time in hours	17	17

5. CONCLUSION :

Throughout our progression, it appears that the first and the second methods in solving the assignment model led to identical results of the objective function, the minimal assignment time is (17) hours, we can use assignment model in case of existence (n) workers for preforming (n) tasks.

6. REFERENCES :

[1] Idriss, Elsiddigldriss Mohamed, Hussein, Elfarazdag Mahjoub Mohamed, “Application of Linear Programming (Assignment Model)” International Journal of Science and Research (IJSR), ISSN (Online):2319-7064, 2013.

[2] Rai, Neha, Rai, khushbu, Khan, A.J “New Approach to Solve Assignment Problem”, International Journal of Innovative science and Research Technology, volume 2, Issue 10, October – 2017 .

[3] Jasim, Anwar Nsaif, “A New Method to Solve Assignment Models”, Applied Mathematical Sciences, Vol. 11, 2017.

[4] Xian-Ying, Ma, “Application of Assignment Model in PE Human Resources Allocatain”, International Conference on Future Energy, Environment and Materials, Available online at www.sciencedirct.com , 2012.