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Determining Optimal Solutions in Learning Outcome Using One to One Fixed Method

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ABSTRACT

General assignment problems include n tasks that must be assigned to m workers where each worker has different competencies in completing each task. This research discusses the problem of solving minimization case assignments using a new method, namely the One-to-One Fixed Method. Completion of the One-to-One Fixed method starts by seeing whether the data obtained is balanced or not, if not then an additional dummy, if yes then proceed to the next stage, calculate the penalty by subtracting each row and column with the smallest element, and combining the results of subtracting rows and column into one table. Next, count those that are affected by the line 2 times and are added and are not affected by the line minus the smallest cost that is not affected by the line, if you have not found the optimal result then repeat the steps until you find the optimal result. In the problem of assigning the minimization case after using the One to One Fixed method on a 3 × 3 matrix, the total cost to be incurred by the Islamic Higher Education is $22. With the allocation: learning outcome 1 is done by lecturer 3 at Department 3 = $ 6, learning outcome 2 is done by lecturer 1 at Department 2 = $ 9, learning outcome 3 is done by lecturer 2 at Department 1 = $ 7.

Keywords: *solid assignment problem, one-to-one fixed method, optimal solution.*

1. INTRODUCTION

Operations Research is a type of problem solving in mathematics. Where there is a problem that contains assignments in Operations Research. Operations research is a decision-making approach characterized by the application of scientific knowledge through collaborative interdisciplinary efforts aimed at determining the best use of limited resources.

The rapid advancement of technology is a means of assisting the expansion of various businesses that produce goods and services. Every effort is now required to improve the efficiency and effectiveness of human resource utilization. Essentially, efficiency with effectiveness emphasizes resources in order to avoid work overlap in a company's goods or services. Operations management frequently faces issues relating to the optimal allocation of various types of productive resources, particularly labor. This is known as the assignment problem.

To produce an optimal work process in a company, especially one that manufactures products based on where the order must be processed using a human-powered machine, the right determination or assignment is required. [7].

Many previous studies on assignment problems have been conducted, including a new technique for determining the optimal solution to assignment problems with maximization objective functions [17]. The assignment problem is a subset of linear programming [18, 19, 20, 21, 22]. The One to One Fixed Method will be used in this study to determine optimal solutions in learning outcomes.

2. LITERATURE REVIEW

One to One fixed method has been proposed in this article to find the optimal solution for solid assignment problems (SAP). The One to One fixed method procedure is illustrated with a numerical example. The results achieved by the proposed procedure will be support people's decision making to make the right decisions when using a variety of solid assignment problems.

One-to-one Fixed Method Algorithm as follows:

Step 1: Find the row deviation table for given problem. Notice that each column contains at least one zero. Otherwise, subtract the least cost entry for each column from all the entries in the row deviation (RD) table column.

Step 2: Find the column deviation table for the given problem (P). Note that each row contains at least one zero. Otherwise, subtract each row's smallest cost entry from all entries in the RD table row.

Step 3: Create a cost deviation table, using steps 1 and 2. Notice that each row and column contains at least one (0,0) cell. If there are no (0,0) cells (for example, (, 0) or (0,), then subtract the minimum cost of the i-th row or j-th column from all elements in the i-th row or in the th column j CDT.

Step 4: Analyze if there is an opportunity to share each worker/job/company with job/company/corresponding workers (each) using the cell that has zero cost, then go to step 7. If not, go to step 5.

Step 5: Optimality test If the CDT sequence equals the least number of closing lines, optimality is reached. If the CDT sequence is greater than the least number of closing lines, proceed to Step 6.

Step 6: Fix the fewest entries of CDT not covered by any row. Subtract this entry from all entries that are not covered and add this to all entries that lie at the intersection of this straight line instead of changing the remaining entries that lie on the straight line.

Step 7: Check if it is possible to allocate each worker/job/company with the corresponding job/worker/company (respectively) through the cells having zero costs from the subtracted table. If not, change it using Step 5.

Step 8: Repeat Steps 5 to 7, until the optimal allotment is obtained.

3. RESULTS AND DISCUSSION

3.1. Case Studies

In this case three different departments (C1, C2, C3), three lecturers (W1, W2, W3), and three learning outcomes (J1, J2, J3). By considering the ability to teach, the Head of Department estimates the cost of lecturers in each learning outcome, then determines the assignment of lecturers to its learning outcome so as to minimize the total cost, the cost is in dollars (Table 1).

Table 1. Numerical Example Data For Assignment Problem Using One To One Fixed Method

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	10	8	12	12	9	27	15	10	13
W2	8	6	7	9	6	12	7	11	12
W3	9	7	6	10	7	12	8	6	8

3.2. Analysis Data

Solving assignment problems with 3×3 matrix using the One to One Method:

Step 1: Compile the assignment matrix table and check whether the given data is balanced or not (Table 2).

Table 2. Initial Data For 3x3 Matrix Assignment Costs

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	10	8	12	12	9	27	15	10	13
W2	8	6	7	9	6	12	7	11	12
W3	9	7	6	10	7	12	8	6	8

= the lowest cost in each row.

Because the data is balanced, proceed to the next stage. Since each row does not find 0 then calculate the penalty with the formula $tijk = cijk - vj$, with vj = the lowest cost column j-th (Table 3).

Table 3. Subtraction Data In Each Row

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	2	0	4	4	1	19	7	2	5
W2	2	0	1	3	0	6	1	5	6
W3	3	1	0	4	1	6	2	0	2

Table 4. Initial Data Assignment Cost Matrix 3x3

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	10	8	12	12	9	27	15	10	13
W2	8	6	7	9	6	12	7	11	12
W3	9	7	6	10	7	12	8	6	8

= the lowest cost in each column

Step 2: Since each column does not find 0 then calculate the penalty with the formula $tijk = cijk - vj$, with vj = the lowest cost column j-th (Table 5).

Table 5. Subtraction Data In Each Column

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	4	2	6	6	3	21	9	4	7
W2	2	0	1	3	0	6	1	5	6
W3	3	1	0	4	1	6	2	0	2

Step 3: Since the first row Table 6 does not have (0,0) then subtract it with the smallest cost (0,2) (Table 7).

Table 6. Result Data from Step 1 and 2 with $CDT = (pijk , tijk)$

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	(2,4)	(0,2)	(4,6)	(4,6)	(1,3)	(19,21)	(7,9)	(2,4)	(5,7)
W2	(2,2)	(0,0)	(1,1)	(3,3)	(0,0)	(6,6)	(1,1)	(5,5)	(6,6)
W3	(3,3)	(1,1)	(0,0)	(4,4)	(1,1)	(6,6)	(2,2)	(0,0)	(2,2)

Table 7. Result Data Reduce The First Row with The Smallest Cost (Final Cdt)

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	(2,2)	(0,0)	(4,4)	(4,4)	(1,1)	(19,19)	(7,7)	(2,2)	(5,5)
W2	(2,2)	(0,0)	(1,1)	(3,3)	(0,0)	(6,6)	(1,1)	(5,5)	(6,6)
W3	(3,3)	(1,1)	(0,0)	(4,4)	(1,1)	(6,6)	(2,2)	(0,0)	(2,2)

Table 8. Data on The Results of Subtracting Step 5 from Figure 2

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs	J1			J2			J3		
W1	(0,0)	(0,0)	(3,3)	(1,1)	(0,0)	(16,16)	(4,4)	(1,1)	(2,2)
W2	(2,2)	(2,2)	(2,2)	(2,2)	(1,1)	(5,5)	(0,0)	(6,6)	(6,6)
W3	(2,2)	(2,2)	(0,0)	(2,2)	(1,1)	(4,4)	(0,0)	(0,0)	(0,0)

Step 4: Because Department 1 (C1) have no value (0,0) go to Step 5.

Step 5: Test the optimality by drawing a line that passes through (0,0), if the line number is the same as the row or column number then the solution is optimal. Since the number of lines is not the same as the number of rows or columns, go to step 6 (Figure 1).

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs		J1			J2			J3	
W1	(2,2)	(0,0)	(4,4)	(4,4)	(1,1)	(19,19)	(7,7)	(2,2)	(5,5)
W2	(2,2)	(0,0)	(1,1)	(3,3)	(0,0)	(6,6)	(1,1)	(5,5)	(6,6)
W3	(3,3)	(1,1)	(0,0)	(4,4)	(1,1)	(6,6)	(2,2)	(0,0)	(2,2)

Figure 1 Data For Working On Step 5 From Table 7

Step 6: Those who are hit by a line two times are added and those who are not hit by a line are subtracted by the smallest cost that is not hit by a line, namely (1,1). If we draw a line only horizontally the results will remain the same as Table 7.

= Indicates the smallest cost that does not hit the line.

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs		J1			J2			J3	
W1	(0,0)	(0,0)	(4,4)	(2,2)	(0,0)	(17,17)	(5,5)	(2,2)	(3,3)
W2	(,1)	(1,1)	(2,2)	(2,2)	(0,0)	(5,5)	(0,0)	(6,6)	(6,6)
W3	(2,2)	(2,2)	(1,1)	(3,3)	(1,1)	(5,5)	(1,1)	(1,1)	(1,1)

Figure 2 Data On The Results Of Reducing Step 5 From Figure 1

Step 7 : Because Department 1 (C1) has no value (0,0), repeat step 5. Test the optimality by drawing a line that passes through (0,0), if the line number is the same as the row or column number then the solution is optimal. Since the number of lines is not the same as the number of rows or columns, go to step 6. Those who are hit by a line two times are added and those who are not hit by a line are less than the smallest cost that is not hit by a line, namely (1,1) (Figure 2).

Because Department 3 (C3) have no value (0,0), repeat step 5. Test the optimality by drawing a line that passes through (0,0), if the line number is the same as the row or column number then the solution is optimal. Since the number of lines is not the same as the number of rows or columns, go to step 6. Those who are hit by a line two times are added and those who are not hit by a line are subtracted by the smallest cost that is not hit by a line, namely (1,1).

Optimal results have been obtained, so learning outcome 1 is done by lecturer 3 at department 3, learning outcome 2 is done by lecturer 1 at department 2, and learning outcome 3 is done by lecturer 2 at department 1.

Table 9 Data On The Results Of The Allocation Of Tasks From Table 8 To Table 1

Companies	C1			C1			C1		
		C2			C2			C2	
			C3			C3			C3
Worker/Jobs		J1			J2			J3	
W1	10	8	12	12	9	27	15	10	13
W2	8	6	7	9	6	12	7	11	12
W3	9	7	6	10	7	12	8	6	8

= Task Allocation

Then it is obtained that learning outcome 1 is done by lecturer 3 in department 3 with an educational cost of \$ 6, learning outcome 2 is done by lecturer 1 in department 2 with an educational cost of \$ 9, learning outcome 3 is done by lecturer 2 in department 1 with an educational cost of \$7. Thus, total cost = \$6 + \$9 + \$7 = \$22.

So the results of calculations using the one-to-one fixed method produce a minimum total cost for assignment problems issued for 3 different learning outcomes and a minimum cost of \$22.

4. CONCLUSION

One to One Fixed method can solve an assignment problem that aims to get the optimal solution. To get the optimal solution by seeing whether the data obtained is balanced or not, if not then a dummy is added, if yes then proceed to the next step, calculate the penalty by subtracting each row and column with the smallest element, and combining the results of subtracting rows and columns into 1 table (CDT). Next, count those that are affected by the line 2 times and are added and are not affected by the line minus the smallest cost that is not affected by the line, if you have not found the optimal result then repeat the steps until you find the optimal result. In the problem of assigning the minimization case after using the One to One method on a 3 × 3 matrix, the total cost to be incurred by the Islamic Higher Education is \$22. By allocation: learning outcome 1 is done by lecturer 3 in department 3 = $6, learning outcome 2 is done by lecturer 1 in department 2 = $9, and learning outcome 3 is done by lecturer 2 at department 1 = $7. For further research, the authors suggest comparing the One to One method with other optimal solution methods such as the Hungarian method and using unbalanced case examples with data sizes larger than 3×3 in another topic in higher education field.

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