Optimization of Personnel Assignment Problem Based on Traveling Time by Using Hungarian Methods: Case Study on the Central Post Office Bandung

Sudradjat Supian¹, Sri Wahyuni², Julita Nahar³, Subiyanto⁴*

¹,²,³Department of Mathematics, Faculty of Mathematics and Natural Science, Universitas Padjadjaran, Indonesia
⁴Department of Marine Science, Faculty of Fishery and Marine Science, Universitas Padjadjaran, Indonesia

*Corresponding author: subiyanto17@gmail.com

Abstract. In this paper, traveling time workers from the central post office Bandung in delivering the package to the destination location was optimized by using Hungarian method. Sensitivity analysis against data changes that may occur was also conducted. The sampled data in this study are 10 workers who will be assigned to deliver mail package to 10 post office delivery centers in Bandung that is Cikutra, Padalarang, Ujung Berung, Dayeuh Kolot, Asia-Africa, Soreang, Situ Saeur, Cimahi, Cipedes and Cikeruh. The result of this research is optimal traveling time from 10 workers to 10 destination locations. The optimal traveling time required by the workers is 387 minutes to reach the destination. Based on this result, manager of the central post office Bandung can make optimal decisions to assign tasks to their workers.

1. Introduction
The personnel assignment problem is a special case of the transportation problem. It arises in a variety of decision-making situations. A distinguishing feature of the personnel assignment problem is that one worker is assigned to one and only one task [1]. In general, the assignment problem includes $n$ tasks that must be assigned to $n$ workers where each worker has different competencies in completing each task [8]. The purpose of the assignment problem is to assign each task appropriate to the worker so that the total expenditure of resources to complete all tasks can be optimized. The optimized resource can be an assignment fee, time spent on completing tasks, mileage and so on.

Many researchers have been applied assignment problem to solve decision-making situations. A new approach to one sided assignment problems was developed by Sasaki [6]. Maxon and Bhadury [3] proposed assignment problem with repetitive tasks and tried to introduce a human element into the analysis. A simple random assignment problem with a unique solution was proposed by Bogomolnaia and Moulin [2]. Nuass [4] described a special purpose branch-and-bound algorithm for solving assignment problems. Sourd [7] studied the continuous assignment problem with the aim of solving
scheduling problems with irregular cost functions. Odior et. al. [5] addressed a problem of effectiveness of feasible solutions of assignment problems.

This research discusses how to optimize personnel assignment problem then solved by using Hungarian method. This optimization process is applied to case study of the central post office Bandung in assigning employees to deliver the packet to the destination location based on several criteria owned by each employee and also conducted a sensitivity analysis of data changes that may occur so as not to change the optimal assignment from the initial problem.

2. Materials and Methods

The concept of assignment problem based on traveling time by using Hungarian methods was applied to solve a problem for case study on the central Post Office Bandung. Data collected (estimated time requirements in minutes) from the central Post Office Bandung is shown in Table 1 below.

| Worker | Area | | | | | |
|--------|------|---|---|---|---|---|---|---|---|
| 1      | I    | 26 | 40 | 27 | 35 | 39 | 70 | 30 | 75 | 63 | 30 |
| 2      | II   | 30 | 45 | 32 | 32 | 35 | 75 | 30 | 79 | 62 | 32 |
| 3      | III  | 29 | 30 | 20 | 22 | 30 | 80 | 34 | 80 | 62 | 30 |
| 4      | IV   | 26 | 32 | 25 | 30 | 30 | 86 | 26 | 75 | 60 | 29 |
| 5      | V    | 29 | 37 | 27 | 31 | 55 | 85 | 27 | 76 | 60 | 30 |
| 6      | VI   | 27 | 37 | 30 | 33 | 34 | 90 | 30 | 69 | 57 | 35 |
| 7      | VII  | 27 | 42 | 30 | 35 | 30 | 69 | 34 | 66 | 58 | 36 |
| 8      | VIII | 30 | 41 | 26 | 28 | 30 | 87 | 23 | 67 | 58 | 37 |
| 9      | IX   | 25 | 41 | 29 | 36 | 40 | 90 | 30 | 78 | 60 | 34 |
| 10     | X    | 25 | 40 | 23 | 30 | 38 | 88 | 32 | 68 | 62 | 28 |

Table 1 shows that the traveling time of 10 employees to deliver mailing packets to 10 post office delivery centers in Bandung that is Cikutra (I), Padalarang (II), Ujung Berung (III), Dayeuh Kolot (IV), Asia-Africa (V), Soreang (VI), Situ Saeur (VII), Cimahi (VIII), Cipedes (IX) and Cikeruh (X).

3. Result and Discussion

The goal of the assignment problem is to minimize the traveling time of of 10 employees to deliver mailing packets to 10 post office delivery centers in Bandung. An important characteristic of this assignment problem is the number of workers is equal to the number of destinations. It is explained in the following way.

- Only one job is assigned to worker.
- Each worker is assigned with exactly one destination.

Based on the data collected, manager of the Central Post Office Bandung has ten workers for ten separate destinations and the traveling time of assigning each destination to each worker is given. His goal is to assign one and only destination to each worker in such a way that the total traveling of assignment is minimized.

Balanced assignment problem: The number of workers is equal to the number of destinations. The mathematical model of the assignment problem in this case can be written as follows:
Min \( T = \sum_{i=1}^{10} \sum_{j=1}^{10} c_{ij}x_{ij} \)

s.t \( \sum_{j=1}^{10} x_{ij} = 1 \); \( i = 1,2,\ldots,10 \)

\( \sum_{i=1}^{10} x_{ij} = 1 \); \( j = 1,2,\ldots,10 \)

\( x_{ij} = 0 \) or \( 1 \), for \( i \) and \( j \)

where:

\[ x_{ij} = \begin{cases} 1, & \text{if worker } i \text{ go to destination } j \\ 0, & \text{if worker } i \text{ does not go to destination } j \end{cases} , \quad i = 1,2,\ldots,10 \text{ and } j = 1,2,\ldots,10. \]

Based on data in the Table 1, the optimal assignments matrix was produced by applied the Hungarian method in this case as shown in Table 2 below.

| Worker | Area |  I  | II | III | IV  | V  | VI | VII | VIII | IX  | X  |
|--------|------|-----|----|-----|-----|----|----|-----|------|-----|----|
| 1      |      | 3   | 7  | 4   | 7   | 9  | 0  | 4   | 8    | 7   | 2  |
| 2      |      | 3   | 8  | 3   | 0   | 1  | 1  | 0   | 8    | 2   | 0  |
| 3      |      | 9   | 0  | 0   | 7   | 3  | 16 | 11  | 16   | 9   | 5  |
| 4      |      | 4   | 0  | 3   | 3   | 7  | 11 | 4   | 9    | 5   | 2  |
| 5      |      | 5   | 3  | 3   | 2   | 4  | 14 | 0   | 8    | 3   | 1  |
| 6      |      | 3   | 3  | 6   | 1   | 5  | 19 | 3   | 1    | 0   | 6  |
| 7      |      | 3   | 10 | 8   | 8   | 1  | 0  | 9   | 0    | 3   | 9  |
| 8      |      | 7   | 8  | 3   | 0   | 0  | 17 | 2   | 0    | 2   | 9  |
| 9      |      | 0   | 6  | 4   | 6   | 8  | 18 | 2   | 9    | 2   | 4  |
| 10     |      | 2   | 7  | 0   | 2   | 8  | 18 | 6   | 1    | 6   | 0  |

Based on the optimal solution in Table 2, the assignment of workers from Central Post Office Bandung to each post office delivery centers in Bandung can be seen in Table 3 below.

| Worker | Post office delivery centers in Bandung |
|--------|----------------------------------------|
| 1      | Soreang                                |
| 2      | Dayeuh Kolot                           |
| 3      | Ujung Berung                           |
| 4      | Padalarang                             |
| 5      | Situ Saeur                             |
| 6      | Cipedes                                |
| 7      | Cimahi                                 |
| 8      | Asia-Afrika                            |
| 9      | Cikutra                                |
| 10     | Cikeruh                                |

By adjusting the decision variables with the initial table (Table 1) then the total traveling time (T) is 387 minutes.
In order to determine the data changes range of traveling time that do not change the assigned optimal assignment of workers, the sensitivity analysis was done. Sensitivity analysis to change of objective function coefficient from traveling time data was obtained as shown in Table 4.

### Table 4. Range of Travel Time Coefficient

| Worker | Area | I | II | III | IV | V | VI | VII | VIII | IX | X |
|--------|------|---|----|-----|----|---|----|-----|------|----|---|
| 1      |      | [23, 71) | (33, 71) | (23, 71) | (28, 71) | (30, 71) | (−∞, 71] | (26, 71) | (67, 71) | [56, 71) | (28, 71) |
| 2      |      | (27, 71) | (37, 71) | (27, 71) | (−∞, 33] | (34, 71) | (74, 71) | (29, 71) | (71, 71) | (60, 71) | (31, 71) |
| 3      |      | (20, 71) | (29, 71) | (−∞, 21] | (25, 71) | (27, 71) | (67, 71) | (23, 71) | (64, 71) | (53, 71) | (25, 71) |
| 4      |      | (22, 71) | (−∞, 33) | (22, 71) | (27, 71) | (29, 71) | (69, 71) | (25, 71) | (66, 71) | (55, 71) | (27, 71) |
| 5      |      | (24, 71) | (34, 71) | (24, 71) | (29, 71) | (31, 71) | (71, 71) | (−∞, 28] | (68, 71) | (57, 71) | (29, 71) |
| 6      |      | (24, 71) | (34, 71) | (24, 71) | (29, 71) | (31, 71) | (71, 71) | (27, 71) | (68, 71) | (−∞, 58] | (29, 71) |
| 7      |      | (22, 71) | (32, 71) | (22, 71) | (27, 71) | (29, 71) | (68, 71) | (25, 71) | (−∞, 67] | (55, 71) | (27, 71) |
| 8      |      | (23, 71) | (33, 71) | (23, 71) | (27, 29] | (−∞, 31] | (70, 71) | (26, 71) | (66, 71) | (56, 71) | (28, 71) |
| 9      |      | (−∞, 26] | (35, 71) | (25, 71) | (30, 71) | (32, 71) | (72, 71) | (28, 71) | (69, 71) | (58, 71) | (30, 71) |
| 10     |      | (23, 71) | (33, 71) | (22, 24] | (28, 71) | (30, 71) | (70, 71) | (26, 71) | (67, 71) | (56, 71) | [−∞, 29] |

Based on Table 4, it is obtained the range of coefficients changes from the objective function allowed for each worker to reach the destination location does not change the initial assignment.

### 4. Conclusion

In this paper, the concept of assignment problem has been applied to solve a problem for of the central post office Bandung which had a difficulty in assigning 10 workers to 10 destination locations of post office delivery centers. Based on the data collected, Hungarian Method was used to solve the problem. Optimal assignments of the cases were obtained for the central post office Bandung. It was obtained that, the optimal assignment of workers from Central Post Office Bandung to each post office delivery centers as follows: worker 1 to Soreang, worker 2 to Dayeuh Kolot, worker 3 to Ujung Berung, worker 4 to Padalarang, worker 5 to Situ Saur, worker 6 to Cipedes, worker 7 to Cimahi, worker 8 to Asia-Afrika, worker 9 to Cikutra, worker 10 to Cikeruh. The total optimal number of travelling time of the cases is 387 minutes. The Sensitivity Analysis for assignment issues can illustrate the range of coefficient value changes for the allowed objective function so that this does not change the optimal assignment of the initial problem.

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### References

[1] Boah, D.K., Adu, I. K., and Gyebil, F. J. 2015. Assignment problem of a legal firm in Kumasi, Ghana. *International Journal of Computing and Optimization*, 2(1), 1-5.

[2] Bogomolnaia, A. and Moulin, H. 2002. A Simple Random Assignment Problem with a Unique Solution, *Economic Theory*, 19, 623 - 636

[3] Maxon, S. L. and Bhadury J. 2001. An Ms-excel implementation of a multi-period assignment problem with repetitive tasks, *Proceedings of the 13th Annual CSUPOM Conference*, 123-126
California State University San Bernardino, 39–48.

[4] Nauss, R. M. 2003. Solving the generalized assignment problem: an optimizing and heuristic approach, *INFORMS Journal on Computing*, 15(3), 249 – 266.

[5] Odior, A.O., Owaba, C. and Oyawale, O.E. 2010. Determining Feasible Solutions of a Multicriteria Assignment Problem, *Journal of Applied Sciences and Environmental Management*, 14(1), 35-38.

[6] Sasaki, H. 1995. Consistency and Monotonicity in Assignment Problems, *International Journal of Game Theory*, 24, 373-397.

[7] Sourd F. 2004. The continuous assignment problem and its application to pre-emptive and non-pre-emptive scheduling with irregular cost functions, *Informs Journal on Computing*, 16(2), 198-208.

[8] Taha, H. A.1996. *Riset Operasi, Jilid 1, Edisi ke-5*. Jakarta: Binarupa Aksara.