



The Saving Matrix Method for Improving Distribution Efficiency

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Abstract

The delivery route for the Bandung 40400 Mail Processing Center is determined based on the estimation using the zoning system, and this may trigger delays. This happens because of each vehicle can only deliver to one distribution center at a time. This makes the load factor level of vehicle utilization below 20%. This study aims to obtain the optimal route and delivery schedule to improve distribution efficiency and increase the load factor of vehicle capacity utilization. This quantitative research method uses the Saving Matrix algorithm on all distribution channels. The results obtained indicate that the optimal delivery routes are 5 to 6 cluster. This saves mileage of up to 144 km per route per day and saves distribution costs of up to Rp. 39,146.50 for one delivery. In addition, there was an increase in the load factor of 18.37% for dropping 1 and 16.49% for dropping 2. By using the proposed route, a resume of the delivery schedule is obtained with clearer departure and arrival times and saving times up to 275 minutes. Furthermore, the expansion of the scope of research and comparing the level of effectiveness between distribution centers in various regions can be carried out as a follow-up study.

Keywords—Saving matrix algorithm; Delivery routes; Load factor; Scheduling

Abstrak

Rute pengiriman untuk Pusat Pemrosesan Surat Bandung 40400 ditentukan berdasarkan estimasi yang menggunakan sistem zonasi, dan hal ini dapat memicu keterlambatan. Hal ini terjadi karena setiap kendaraan hanya dapat mengirim ke satu pusat distribusi dalam sekali jalan. Hal ini membuat tingkat load factor utilisasi kendaraan di bawah 20%. Penelitian ini bertujuan untuk mendapatkan rute dan jadwal pengiriman optimal untuk meningkatkan efisiensi distribusi dan meningkatkan load factor utilisasi kapasitas kendaraan. Metode penelitian kuantitatif ini menggunakan algoritma Saving Matrix pada semua jalur distribusi. Hasil yang diperoleh menunjukkan bahwa rute pengiriman yang optimal adalah 5 hingga 6 cluster. Hal ini menghemat jarak tempuh hingga 144 km per rute per hari, dan menghemat biaya distribusi hingga Rp. 39.146,50 untuk satu kali pengiriman. Selain itu terjadi peningkatan pada load factor sebesar 18,37% untuk dropping 1 dan sebesar 16,49% untuk dropping 2. Dengan menggunakan rute yang diusulkan, resume jadwal pengiriman diperoleh dengan waktu keberangkatan dan kedatangan yang lebih jelas dan memberikan penghematan waktu perjalanan hingga 275 menit. Selanjutnya, Perluasan ruang lingkup penelitian dan membandingkan tingkat efektivitas antar pusat distribusi di berbagai daerah dapat dilakukan sebagai penelitian lanjutan.

Kata kunci— Algoritma Saving Matrix; Rute pengiriman; Load Factor; Penjadwalan

I. INTRODUCTION

PT Pos Indonesia (Persero) is a State-Owned Enterprise (BUMN), which is engaged in shipping services and financial services since August 26, 1746. The services are provided by PT Pos Indonesia (Persero) focuses on the activities of sending packages and documents/letters. However, along with the development of online buying and selling, this has led to high demand for package delivery in the community for delivery services and has become one of the triggers for increasingly strong competition between shipping service companies. Therefore,

Article info

Received (17/10/2021)

Revised (21/12/2021)

Accepted (31/07/2022)

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DOI: 10.25124/jmi.v22i2.4239

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to survive, PT Pos Indonesia (Persero) must strive to improve its performance by carrying out delivery distribution activities more optimally (Azis & Azis, 2013).

Post Office Mail Processing Center Bandung 40400 (Distribution Center) has responsibilities and duties at the processing and transportation stages in Bandung City. However, the problem that most often occurs in the distribution of shipments is the late delivery of packages received by consumers. The package delivery route is one of the things that need to be considered because it has a very important influence in the course of the distribution of package delivery activities (Albab & Azis, 2021), as well as it needs on technology to manage them properly (Irijayanti & Azis, 2017). The delivery route currently used the existing route to deliver packages to each Distribution Center of the tertiary network.

Table 1. Package Delivery Routes to Each Distribution Center Tertiary Network Post Office Mail Processing Center Bandung 40400

No	Code	Tertiary Network Area	Delivery Route	Mileage (Km)	Traveling Time (Minute)	Speed
1.	40400 A	DC Sekejati	MPC-DC A-MPC	9,8	22	27
2.	40400 B	DC Ujung Berung	MPC-DC B-MPC	20	30	40
3.	40400 C	DC Cipedes	MPC-DC C-MPC	28	50	34
4.	40400 D	DC Situsaeur	MPC-DC D-MPC	14	32	26
5.	40400 E	DC Asia Afrika	MPC-DC E-MPC	14,6	34	26
6.	40400 F	DC Cikutra	MPC-DC F-MPC	15,4	34	27
7.	40400 G	DC Dayeuhkolot	MPC-DC G-MPC	26	50	31
8.	40400 H	DC Soreang	MPC-DC H-MPC	32	60	32
9.	40400 I	DC Cimahi	MPC-DC I-MPC	38	70	33
10.	40400 J	DC Cikeruh	MPC-DC J-MPC	30	60	30
11.	40400 K	DC Padalarang	MPC-DC K-MPC	45	95	28
12.	40400 L	DC Lembang	MPC-DC L-MPC	46	85	32
13.	40400 M	DC Majalaya	MPC-DC M-MPC	50	95	32
Total of Mileage, Traveling Time, and Traveled Speed				368,8	717	31

In carrying out the delivery process in the tertiary network, Post Office Mail Processing Center Bandung 40400 uses a zoning system. The zoning system is a package delivery system used by Post Office Mail Processing Center Bandung 40400 to serve package delivery in the tertiary network by assigning one delivery vehicle to one Distribution Center area under a predetermined time. This zoning system determines the route of delivery of the packets in Table 1. The above route is still unknown whether it is optimal or not. This is because the determination of the delivery route is only based on estimates without any special method or mathematical calculation. It is necessary to note that the route used will affect the distance to be travelled, the required delivery time, the total shipments to be carried, the total delivery vehicles required and the costs to be incurred. Currently, the Tertiary Network Area of Post Office Mail Processing Center Bandung 40400 has 13 rental vehicles of the Grand Max type with a maximum capacity of 700 kg to serve package delivery to 13 Distribution Center in Bandung City. Several Distribution Center areas are close to each other, but each delivery vehicle can only serve one Distribution Center area that has been determined by Post Office Mail Processing Center Bandung 40400, even though each delivery vehicle possible to make deliveries to several Distribution Centers in one trip.

In addition, the use of this zoning system will affect the level of the load factor or utility of the shipment carried by each vehicle as well as the use of the capacity of the packet delivery vehicle in the tertiary networks (Sutisna & Diningsih, 2018). The company in distributing parcels uses 13 vehicles, with each vehicle being responsible for one Distribution Center. So that each vehicle can only carry the number of shipments for one predetermined destination. This will make the number of shipments carried is not optimal because each delivery vehicle in one dropping can only carry shipments with an average delivery on dropping I weighing 128.56 kg or about 18.37% of vehicle capacity usage and an average delivery in dropping II weighing 115.42 kg or about 16.49% of the use of vehicle capacity according to the route used for 27 days (amount of delivery days in a month). This means that the capacity of the vehicle used (utility level/load factor) is currently still below 20%

and is still classified as very low because there is still enough unused free space. If the amount of shipments carried by each delivery vehicle is still not optimal, it will make the number of vehicles needed to make deliveries and will affect the high cost of shipping (transportation) that must be issued every day.

Based on the research background that has been described above, this research seeks to determine the optimal package delivery route by using the Saving Matrix method to deliver shipments to each Distribution Center and to find out the load factor level of vehicle capacity usage by using the delivery route generated from the calculation of the Saving Matrix method.

II. LITERATURE REVIEW

According to Suntoro (2020:180) the route is a sequence of vehicle trips from the request locations to be visited, and it should be scheduled carefully and precisely (Widyacantika & Azis, 2020). The selection of decisions in transportation strategy involves the selection of means, size of the delivery, determination of routes, and scheduling, where transportation produces one-third or two-thirds of the total logistics costs (Pamungkas, 2019:10; Mizani & Azis, 2021). The decision that is often taken in reducing transportation costs and improving services for customers is to minimize distance or time of determining the route. According to Yuniarti and Astuti (2013:17), the Vehicle Routing Problem (VRP) is a problem in the distribution system that aims to create an optimal route, for a group of vehicles whose capacity is known to meet customer demand with known locations and number of requests. An optimal route is a route that meets various operational constraints, namely having the shortest total distance and travel time to meet customer demands and using a limited number of vehicles.

According to Kurniawan *et al.* (2014:127), there are four general goals of VRP, namely minimizing global transportation costs, related to distance and fixed costs associated with vehicles, minimizing the number of vehicles needed to serve all consumers, balancing routes, for travel time and vehicle payload, minimizing penalties due to unsatisfactory service from consumers. There are three kinds of solutions to the Vehicle Routing Problem (VRP), namely exact, heuristic, and meta-heuristic solutions (Fuadi & Pujotomo, 2019; Iriyanti & Azis, 2012). Heuristic methods provide a way to solve optimization problems that are more difficult and with quality and faster completion time than exact solutions. According to Fuadi and Pujotomo (2019), this heuristic method is quite often used for constructing routes. A method takes into account time and costs savings by considering existing constraints. Then look for the optimal distribution route with the indicator to minimize the time.

The load factor is the division between the existing demand and the capacity available (Putra, 2013; Sugara & Azis, 2020). The load factor can be a clue to find out whether the number of existing fleets is still not sufficient, sufficient, or exceeds the needs of a public transport line and can be used as an indicator in representing the efficiency of a route. Scheduling. According to Suntoro (2020:191) scheduling is the activity of allocating existing resources or machines to run a set of tasks within a certain period. According to Istantiningrum in Suparjo (2017), one of the benefits of scheduling is so that the delivery of goods can be under the time and portion that has been determined. Scheduling also has a purpose, where the scheduling aims for the delivery of goods to be carried out sequentially according to the schedule made. The schedule is in the form of a timetable that is poured into a calendar that is very much needed by the implementers. Some of the scheduling results are in accordance with the routes that have been provided so that the delivery does not exceed the delivery capacity (Suntoro, 2020:191; Pertiwi & Azis, 2022).

In determining the schedule, it is necessary to pay attention to the loading time and unloading time (Puspawan & Azis, 2019). Loading time is the time it takes to load goods into the transport car. While the unloading time is the time needed to unload the cargo from the transport car. Employees carry out the loading process, while the unloading is carried out at the Distribution Center. So, in determining the schedule, one must pay attention to the time (hours) of dropping shipments, loading and unloading times, vehicle speed, and the time required to use the route using the Saving Matrix method (Pamungkas, 2019:56; Azis, 2017).

III. RESEARCH METHODOLOGY

The object of research is to determine the optimal package delivery route using the Saving Matrix to determine whether the proposed route can increase the load factor of the use of vehicle capacity so that it can be more efficient/optimal or not, as well as determining the return delivery schedule by taking into account the distance and time to be traveled, the route used, loading and unloading time using the calculated route using the Saving Matrix method.

According to Sugiyono (2018:2), the research method is a scientific way to obtain data with certain goals and uses. Meanwhile, Kuncoro (2013:3) states that the characteristics of the research method are critical and analytical, conceptual, theoretical, empirical, and systematic. Therefore, in this problem, the method that can support the achievement of these three goals is to use a descriptive method. According to Mukhtazar (2020:10), descriptive research is research that intends to systematically and carefully provide facts and characteristics of certain populations. So it can be concluded that the descriptive method is a way to answer the questions in the problem formulation systematically and based on facts. The author chose to apply the Saving Matrix method because this method is easy to use to determine efficient routes and schedules by providing various savings in terms of time, distance, vehicles and delivery routes, as well as distribution costs, incurred as well as optimizing the use of vehicle capacity (load factor). To conduct this research, the writer needs primary data, secondary data that can support this research. For primary data collection techniques, the authors conducted simple observations and interviews. As for the secondary data collection technique, the author uses distance and travel time data from Google Maps, per kilometer fare data from Bandung City Transportation Service, and literature studies, both company document studies and related journal or book references.

The data analysis used the Saving Matrix method, which start by focusing on the time and cost savings with the existing constraints, then look for the optimal distribution route with the indicator to minimize the time (Fuadi and Pujotomo, 2019:2). There are four stages in determining the optimal route using the Saving Matrix method, namely the preparation of the distance matrix, the second is the preparation of the saving matrix, the third is the determination of routes/vehicles and the last is the determination of the sequences of Distribution Centers in one route. After going through the four stages, the next step is to analyze the savings achieved by comparing the results obtained from the proposed route with the existing route. The savings analysis carried out is to analyze the savings in terms of vehicle use, distance, and distribution costs. This is done to find out whether using the proposed route can make distribution activities more optimal and efficient or not. To answer the second problem formulation regarding the calculation of the load factor level based on the proposed route, namely by processing the data on the number of shipments calculated based on the use of the proposed route that has been determined in the results of the research and discussion of the first problem formulation. After processing the data on the number of shipments, the next step is to calculate the load factor level.

After obtaining the results of the calculation using the load factor level formula (see formula 1), the next step is to analyze the benefits obtained by comparing the results of the load factor level using the proposed route with the existing route. In answering the third formulation regarding determining the optimal delivery schedule, the first thing to do is to calculate the average speed of the vehicle. The results of these calculations are used in determining the delivery schedule. The next step is to determine the delivery schedule where travel time is the most important data in scheduling, namely by dividing the distance by the speed and then multiplying by 60 minutes. The arrival time plus the unloading time equals the departure time from DC to DC. Scheduling is done to ensure that time is used optimally (Feng, *et. al.*, 2017).

$$L_f = \frac{P_{sg}}{c} \times 100\% \dots\dots\dots(\text{Formula 1})$$

Where:

- L_f : Load Factor
- P_{sg} : Total load number
- C : Vehicle capacity.

IV. FINDINGS AND DISCUSSIONS

A. Determination of Routes Using the Saving Matrix Method

As previously explained in the background sub-chapter, the current route (the existing route) uses a zoning system, where each Distribution Center can only be served by one delivery vehicle that has been assigned so

that many distribution activities take place at the Post Office Mail Processing Center Bandung 40400. While in the image map of the tertiary network area of Bandung, several Distribution Centers are close to each other, so that it is still possible for one vehicle to serve deliveries to more than one Distribution Center in one go by taking into account the maximum capacity of the delivery vehicle, the number of requests for shipments at each Distribution Center, and also the distance that must be covered. More details can be seen in Figure 1 as follows.

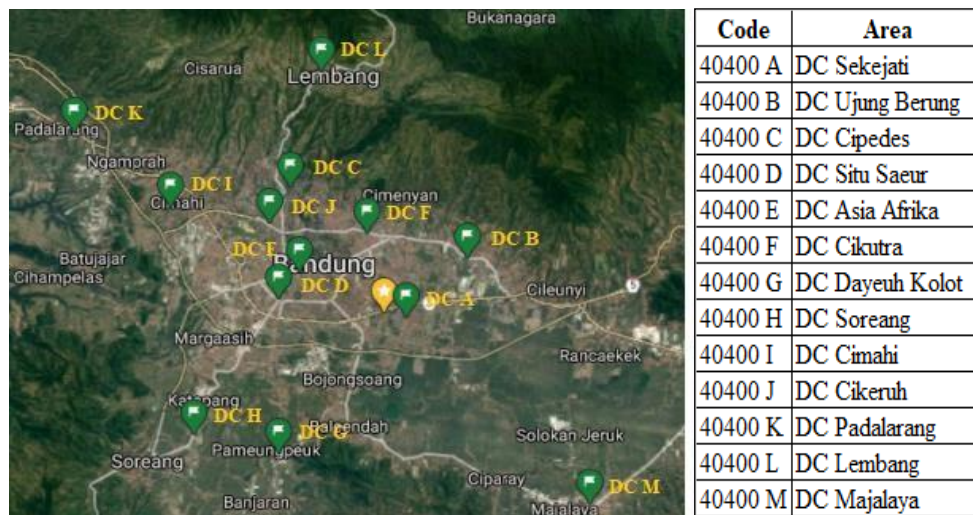


Figure 1. Map of the tertiary network post office distribution center Bandung
Source: www.google.co.id/maps/@-6.9418632, accessed 16 January 2021

The use of optimal routes will provide various benefits to support efficient distribution activities, one of which is to get savings on the route/vehicle used, distance and travel time, and costs incurred during delivery. To get the optimal route, an appropriate and appropriate method is needed to solve the above problems. In this study, the author will use the Saving Matrix method, because this method is known for its benefits to provide savings so that it can increase the efficiency of distribution activities.

To determine the optimal route using the Saving Matrix method, there are four stages, the first is the preparation of the distance matrix, the second is the preparation of the saving matrix, the third is the determination of routes/vehicles and the last is the determination of distribution sequences. After the route generated from the calculation using the Saving Matrix method (proposed route) is formed, the next step is to analyze the savings obtained both in terms of the number of routes/vehicles, mileage, and shipping costs. Next, the author will discuss how to determine the distance matrix, which is as follows.

B. Determination of the Distance Matrix

The distance matrix is a matrix that identifies two locations, namely between the depot (central location) and the node (destination location). To create a distance matrix, the matrix used is a symmetric matrix where the distance from MPC to DC is the same as the distance from DC to MPC.

Based on the table above, the distance matrix can be started from the depot row (MPC), which is the center of the delivery. To get distance data from the depot (origin) to the node (destination) such as from MPC to DC, DC to DC, and from DC to MPC, the authors use data obtained from the Google Maps application at the time of departure. The author uses this data because the Post Office Mail Processing Center Bandung 40400 does not have data on the distance traveled to each Distribution Center. To fill in the distance column, it is necessary to determine which is the depot (origin) and which is the node (destination).

Table 2. Determining the Distance Matrix

		No.	0	1	2	3	4
		Destination/To :	MPC Bandung 40400 (Depot)	Sekejati	Ujung Berung	Cipedes	Situsaeur
No.	Origin/From :	Code	MPC	DC A	DC B	DC C	DC D
0	MPC Bandung 40400 (Depot)	MPC	0,0	4,9	10	14	7
1	Sekejati	DC A	4,9	0,0	12	17	9,3
2	Ujung Berung	DC B	10	12	0,0	13	15
3	Cipedes	DC C	14	17	13	0,0	6,2
4	Situsaeur	DC D	7	9,3	15	6,2	0,0

Based on the table above, the distance matrix can be started from the depot row (MPC), which is the center of the delivery. To get distance data from the depot (origin) to the node (destination) such as from MPC to DC, DC to DC, and from DC to MPC, the authors use data obtained from the Google Maps application at the time of departure. The author uses this data because the Post Office Mail Processing Center Bandung 40400 does not have data on the distance traveled to each Distribution Center. To fill in the distance column, it is necessary to determine which is the depot (origin) and which is the node (destination).

C. Preparation of the Saving Matrix

To compile the savings matrix, data from the distance matrix is needed; this is used to calculate savings from MPC (depot) to DC and from DC to DC to make it easier to determine the route to be chosen. The formula that will be used to compile the savings matrix where the formula has been modified from the general concept of the Saving Matrix method. To construct the savings matrix, the data used is the distance matrix data, both the distance from MPC to DC and from DC to DC. So the variable Co,a (distance from MPC to DC Sekejati) is 4.9 km, variable Co,m (distance from MPC to DC Majalaya) is 25 km and for the variable Ca,m (distance from DC Sekejati to DC Majalaya) is 20 km. Then you will get a savings of 9.9 if you make a delivery visit to DC Sekejati and DC Majalaya in one go. The savings results obtained from these calculations will be entered into the savings matrix column. After the saving matrix column has been filled in, the next step is to determine the value of the largest savings by indicating the value of saving option 1, option 2, and option 3. saving option 2 is light blue and the saving value option 3 is gray. For more details, it can be seen in Table 3. The Saving Matrix, which is as follows.

Table 3. Saving matrix

No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13		
	MPC Bandung 40400 (Depot)	Sekejati	Ujung Berung	Cipedes	Situsaeur	Asia Afrika	Cikutra	Dayeuh Kolot	Soreang	Cimahi	Cikeruh	Padalarang	Lembang	Majalaya		
No.	Code	MPC	DC A	DC B	DC C	DC D	DC E	DC F	DC G	DC H	DC I	DC J	DC K	DC L	DC M	
0	MPC Bandung 40400 (Depot)	MPC	0,0	4,9	10	14	7	7,3	7,7	13	16	19	15	22,5	23	25
1	Sekejati	DC A	4,9	0,0	2,9	1,9	2,6	3	2,7	2,9	1,9	2,5	2,9	-2,6	1,9	9,9
2	Ujung Berung	DC B	10	2,9	0,0	11	2	3,3	11,4	2	2	7	10	4,5	9	13
3	Cipedes	DC C	14	1,9	11	0,0	14,8	14,5	15,3	5	12	22	23,8	18,5	24	3
4	Situsaeur	DC D	7	2,6	2	14,8	0,0	11,4	5,3	9	12	14	13,8	11,5	14	5
5	Asia Afrika	DC E	7,3	3	3,3	14,5	11,4	0,0	7,9	3,3	9,3	15,3	14,3	11,8	15,3	4,3
6	Cikutra	DC F	7,7	2,7	11,4	15,3	5,3	7,9	0,0	2,7	3,7	-5,3	15,3	8,2	13,7	4,7
7	Dayeuh Kolot	DC G	13	2,9	2	5	9	3,3	2,7	0,0	20,4	11	5	7,5	8	17
8	Soreang	DC H	16	1,9	2	12	12	9,3	3,7	20,4	0,0	17	11	13,5	11	11
9	Cimahi	DC I	19	2,5	7	22	14	15,3	-5,3	11	17	0,0	20	32	23	6
10	Cikeruh	DC J	15	2,9	10	23,8	13,8	14,3	15,3	5	11	20	0,0	18,5	26	2
11	Padalarang	DC K	22,5	-2,6	4,5	18,5	11,5	11,8	8,2	7,5	38,5	32	18,5	0,0	23,5	1
12	Lembang	DC L	23	1,9	9	24	14	15,3	13,7	8	11	23	26	23,5	0,0	1,0
13	Majalaya	DC M	25	9,9	13	3	5	4,3	4,7	17	11	6	2	23,5	1	0,0

Article info

Received (dd/month/year)
 Revised (dd/month/year)
 Accepted (dd/month/year)
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 DOI:

D. Determination of Routes or Vehicles

At this stage, the delivery visit will be divided into one travel route by considering the distance traveled the number of shipments, and the maximum capacity of the vehicle. After calculating and determining the value of the selected savings matrix, the next step is to determine the route or vehicle to deliver the shipment. To determine the route or delivery vehicle, route selection data is needed that can be taken based on the previous Saving Matrix calculation. It can be seen in Table 4. Route Options Based on the Matrix of Savings, which are as follows.

Table 4. Route Selection Based on the Savings Matrix

Option	Sekejati	Ujung Berung	Cipedes	Situsaeur	Asia Afrika	Cikutra
1	AM	BM	CL	DC	EI/EL	FJ/FC
2	AE	BF	CJ	DL	EC	FL
3	AB/AG/AJ	BC	CI	DJ	EJ	FB

Option	Dayeuhkolot	Soreang	Cimahi	Cikeruh	Padalarang	Lembang	Majalaya
1	GH	HK	IK	JL	KI	LJ	MG
2	GM	HG	IL	JC	KL	LC	MB
3	GI	HI	IC	JI	KJ/KC	LK	MH

Next is choosing the route that will be used in making deliveries. To include these options into a single route, it is necessary to select the best option by the Distribution Center. The route choices are included in route group 1 to route 6 and the author makes two choices of shipping routes. Where the second option is used if the first option cannot be used because it exceeds the capacity of the vehicle. The second option can still be modified and paired with the first choice according to needs but still pay attention to the description of use.

E. Determining the Orders of Distribution Centers into One Route

This stage is the last stage of the Saving Matrix method, where the purpose of this stage is to sort visits from delivery vehicles to each Distribution Center that has been grouped in the form of clusters so that a travel route is obtained to obtain a minimum distance. Starting with calculating the total distance and number of shipments using route 1 option 1. The purpose of calculating the number of shipments is to ensure that the vehicle can carry the shipment and does not exceed the vehicle's load capacity, while the total distance is used for savings analysis. The final results of determining the distribution center sequences into one route or one vehicle that will be visited by the delivery vehicle, one of which can be seen in Table 5. 2nd Week Route (5 to 10 October 2020) Dropping II, which are as follows.

Table 5. 2nd Week route (5 to 10 October 2020) Dropping II

2 nd week					
(05/10/2020)	(06/10/2020)	(07/10/2020)	(08/10/2020)	(09/10/2020)	(10/10/2020)
0-E-0	0-D-E-0	0-E-0	0-E-0	0-D-E-0	0-D-E-0
0-D-C-J-L-0	0-C-J-L-0	0-D-J-L-0	0-D-J-L-0	0-C-J-L-0	0-C-J-L-0
0-I-K-0	0-I-K-0	0-C-I-K-0	0-C-I-K-0	0-I-K-0	0-I-K-0
0-G-H-0	0-H-G-M-0	0-G-H-0	0-G-H-0	0-H-G-M-0	0-H-G-M-0
0-A-M-0	0-A-B-F-0	0-A-M-0	0-A-M-0	0-A-B-F-0	0-A-B-F-0
0-F-B-0		0-F-B-0	0-F-B-0		
6 Route	5 Route	6 Route	6 Route	5 Route	5 Route

After determining and obtaining the proposed route, the next step is to analyze the savings obtained in terms of vehicle use/route, mileage, and distribution costs. Wherefrom the application of the Saving Matrix method in determining shipping routes, savings of 7 to 8 are obtained using routes/vehicles, from the previous use of 13 routes/vehicles to 5 to 6 use of routes/vehicles every day. In terms of mileage, it results in savings with an

Article info

Received (dd/month/year)

Revised (dd/month/year)

Accepted (dd/month/year)

Corresponding_author@email.com

DOI:

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average of 143 km for dropping I; and 144 km per day for dropping II every day. The distance traveled by the vehicle will also affect the costs to be incurred during the delivery. The author uses the fare per kilometer data provided by the Department of Transportation of the City of Bandung. Based on the Governor of West Java Regulation Number 38 of 2013 concerning the Basic Tariff for the Upper and Lower Limits between Cities within the Province where the upper limit tariff for small buses AKDP economy class is Rp. 271.69 for every kilometer. The fare is a per kilometer fare that does not include other overhead costs, the fare will be multiplied by the mileage generated from the route used, the following are the savings obtained in terms of vehicle/route use, mileage, and distribution costs using the proposed route.

The cost of distribution (shipping) using the proposed route is an average of Rp. 61,400.93 per day for dropping I, and an average of Rp. 61,025.77 per day for dropping II. The cost of distribution (delivery) is lower than before, which if using the existing route must cost Rp. 100,199.27. To find out how much distribution (shipping) cost savings are obtained, it is necessary to reduce the distribution costs (shipping) of the existing route and the proposed route. So that obtained savings of Rp. 38,798.34 for dropping I resulting from a reduction of between Rp. 100,199.27 with 61,400.93. And obtained savings of Rp. 39,146.50 for dropping II resulting from a reduction of between Rp. 100,199.27 with 61,025.77.

F. Calculation of the Load Factor Level of Vehicle Capacity Usage Based on the Proposed Route

The load factor level or utility level is a load factor that can be used as a guide to determine whether the number of existing fleets is still insufficient, sufficient, or exceeds the need to carry shipments to each Distribution Center. The level of load factor that will be taken into account by the author aims to determine whether using the proposed route from the calculation method can optimize the use of available vehicle capacity or not. This is done to ensure that the proposed route can increase the load factor so that it can further optimize the use of vehicle capacity. To find out how big the load factor level is for the use of vehicle capacity, it is necessary to request delivery data for each Distribution Center in October 2020 based on the proposed route used for 27 days (number of delivery days in a month). The data needed is data on the number of requests for shipments based on the proposed route. Based on the calculation, it can be concluded that by using the proposed route in dropping I, there is an increase in the load factor level of 20.92% from the previous one (the existing route) of 18.37% to 39.29%. Meanwhile, in dropping II, there was an increase of 19.24% from the previous one (the existing route) of 16.49% to 35.73%.

G. Determining the Optimal Delivery Schedule

If the proposed route has been established, then the delivery schedule is determined so that the delivery of letters/documents or packages can arrive following the time determined by the Post Office Mail Processing Center Bandung 40400. To determine the schedule for sending letters/documents or packages, it is necessary to consider loading times (enter load) and unloading time. In addition, to determine the scheduling required data on mileage and average speed to get travel time from origin to destination, this is done so that the time used is more optimal and nothing is wasted so that the shipment can arrive immediately and be distributed on time into the hands of consumers (recipients). Therefore, the first step that must be taken into account in calculating the average vehicle speed; at this stage, it is found that the average vehicle speed is 31 km/hour.

After determining the delivery schedule the next thing to do is determine the departure schedule. Travel time is the most important data in the schedule by dividing the distance by the speed and then multiplying by 60 minutes. The loading time plus the preparation start time (T) is the same as the departure time (WB). Departure time plus travel time (Wth) equals arrival time (WT). The arrival time plus the unloading time equals the departure time from DC to DC. Scheduling is done to ensure that time is used optimally. The final form of determining the delivery schedule based on the route generated from the calculation using the Saving Matrix method is that it contains the delivery route, scheduled departure time, and arrival time in the form of a resume. Next, the writer will present a resume for the scheduling of dropping I and dropping II, this is because on that date there are three different sequences of routes in one week. While the scheduled resume for other dates can adjust to the scheduled resume presented by the author based on the route used on that date.

The last step is to calculate the average savings, either by adding up what is in the savings column and then dividing the amount of data or by reducing the existing average travel time minus the average travel time for the proposed route, the results will remain the same. So that after being calculated, savings will be obtained by using the proposed route, namely for dropping I, the savings obtained are 273 minutes with a total travel time of 444 minutes from 717 minutes (the existing route). Meanwhile, for dropping II, the savings obtained were 275 minutes with a total travel time of 442 minutes from 717 minutes (the existing route).

V. CONCLUSIONS AND RECOMMENDATIONS

From the result, it can be concluded that the proposed route can optimize the use of vehicle capacity and reduce the available unused capacity. This is evidenced by an increase in the load factor level of 20.92% for dropping I from the previous one (the existing route) of 18.37% to 39.29%. Meanwhile, in dropping II, there was an increase of 19.24% from the previous one (the existing route) of 16.49% to 35.73%. Determining the delivery schedule by using the proposed route provides clearer scheduling results by considering various existing things. This results in a resume of the scheduled departure and arrival times of three different route sequence clusters. The savings in terms of travel time were for dropping I the savings are 273 minutes and for dropping II is 275 minutes every day. Further research is to recalculate carefully the shipping route by applying the Saving Matrix method. This recalculation can be used as a reference to be even better in optimizing distribution activities. Expanding the scope of research and comparing the level of effectiveness between distribution centers in various regions can carry out as further research as well. The expanding research scope can be done in two ways, namely conducting research at the industrial level by involving various companies with similar business fields, and exploring or deepening the interrelationships between variables or research constructs.

ACKNOWLEDGMENT

The authors would like to thanks to Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia and Ekuitas Business School (STIE Ekuitas) Bandung.

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