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# The Analysis of a Distribution Route for The Logistics of The User Material Uses The Saving Matrix Method at PT. X

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***ABSTRACT***

*PT X Tambun Field engages in exploration and production in the upstream oil and gas sector in each mining concession area. One of the activities carried out by the company, one of the activities carried out is the transportation and distribution of raw materials. The transportation and distribution process affects the number of company expenses at PT X. For PT X, the distribution process is expected to be as effective and efficient as possible to minimize transportation costs. This study aims to reduce transportation and distribution costs in PT X. The analytical tool used is the matrix savings method. The results obtained, distribution, reduction of 48.94% distance and equipment rental costs of 43.39% for shipments from the warehouse and distance costs of 32.31% and equipment rental costs of 30.32% for delivery from PT X Tambun Field.*

*Keywords: Transportation, Saving Matrix, Distribution, Efficiency*

## INTRODUCTION

Delivery of materials from suppliers to the company's warehouse is essential to monitor (Wicaksono, 2014). In addition to paying attention to the material ordered to arrive safely to the destination, material delivery, of course, also considers the economic aspect. Because the delivery of materials affects the finances of a company, taking into account the price of the material itself and the usual shipping transportation.

Transportation and distribution are some of the things that affect a company's competitive advantage because they can reduce costs such as transportation costs. In addition, transportation costs can increase company profits if they can be adequately managed (R. Yuniarti and M. Astuti, 2013).

PT X Tambun Field is an auxiliary of PT Y (Persero) and is involved in exploration and production in the upstream gas and oil sector to manage each mining concession (WKP) owned by PT Y. in Asset 3 (West Java Section), where PT X Tambun Field is one of them based in the Cirebon area.

PT X Tambun Field has 69 drilled wells, of which 30 are production wells, and 16 are injection wells. This production well produces grass production of ± 15,000 barrels (bbls), and injection produces ± 14,500 barrels of water per day injected water (bwpd). In its core business processes, namely exploration and production of oil and gas, PT X requires supporting services in operational activities so that they can run effectively and efficiently, especially in the process of procuring goods or services and the process of transporting materials that users in supporting the production process will use. This function is performed by the Division of SCM (Supply Chain Management), in which there is an ongoing part of the procurement process, receiving, transportation, warehouse, and yard.

The way that can be done to reduce transportation costs is to make the system as efficient as possible from the distribution and use of the type of transportation used (Pujawan, 2005). PT X Tambun Field also considers it in material delivery.

The transportation and distribution process affects the company's expenses at PT X Tambun Field. For PT X Tambun Field, the distribution process is expected to be as effective and efficient as possible to minimize transportation costs.

Long distances and a long time in transferring materials and the material distribution process cause high transportation costs (Moengin et al., 2020). One of the steps to plan the distribution route of the material used by users at PT X. The delivery routes will significantly affect the travel costs and rental vehicles used. The more effective the distribution route, the more cost-efficient it will be.

Existing distribution routes can be explored by managing the transportation and distribution of PT X Tambun Field material shipments. The method to save the matrix is to make the distribution distance effective and choose the best route with several alternative considerations. Improving the distribution route of raw materials currently running aims to make the company's distribution process run more efficiently and optimally. The saving matrix method is used because this method requires data such as the distance between the warehouse and PDT CS, RDL CS, PDM CS, transportation equipment capacity, and material transportation available in the company's historical data. By applying the method, it is a saving matrix expected to reduce the distance travelled during distribution and distribution costs so that this method can be optimally applied at PT X to obtain an efficient and optimal distribution route.

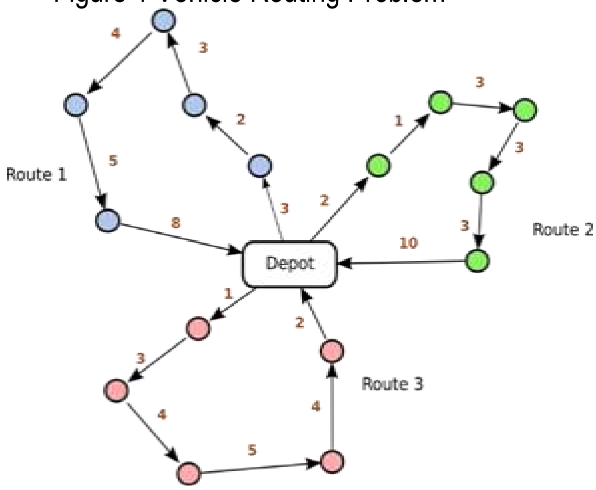
## Literature Review

### Vehicle Routing and Scheduling

The Vehicle Routing Problem discusses how to attract consumers using only the tools they have. The vehicle routing problem is a complex combinatorial optimization problem in the real world. The problems discussed in the vehicle routing problem are closely related to the travelling salesman problem. The Vehicle Routing Problem becomes the Traveling Salesman Problem when only one transportation means whose capacity is infinite (Barcelo et al., 2005).

Vehicle Routing and Scheduling aims to optimize the distance travelled by vehicles in carrying materials by determining each vehicle's route in meeting consumer demand (Ikfan and I. Masudin, 2013). Figure 1 shows an illustration of a VRP.

Figure 1 Vehicle Routing Problem




### Transportation and Distribution Management

Transportation and distribution management is a way of managing the movement of a material from its initial place to the consumer and where that movement forms or produces a network Pujawan, 2005).

In other cases, the role of transportation and distribution networks is vital. Transportation and distribution networks move products from production locations to consumer locations where distance is sometimes restricted. The ability to deliver products to consumers on time, inappropriate quantities, and in good conditions will determine whether the product is ultimately competitive in the market.

A. Essential Functions of Distribution and Transportation Management

Manufacturing companies can hand overall transportation and distribution activities to third parties [8]. The definition of distribution and transportation functions is generally the movement of products from one location where the product is produced to where the product will be used Pujawan, 2005). Transportation and distribution management contains several physical activities that can be seen, such as storing and shipping products, non-physical functions in the form of information processing activities, and services to customers (Suparjo, 2017).

B. Determination of Delivery Routes and Schedules

A crucial operational decision in distribution management determines the schedule for the material to be sent and the transportation route for sending the material. The company usually makes this operational decision because its activities are very vital. The delivery schedule and the route to be taken by the shipping carrier will significantly affect the shipping costs Pujawan, 2005).

Problems in a company regarding scheduling and determining shipping routes can be overcome in several ways. The purpose of solving this problem is because scheduling and route determination aim to minimize mileage, minimize shipping costs or minimize time.

## METHOD

Research methods will be used in a study until the research is completed and draws conclusions. Table 1 shows the techniques for collecting data in this study.

Table 1 Data Collection Techniques

| No | Type Data | Method | Source |
|---|---|---|---|
| 1 | Distance Data | Observation | Google Maps |
| 2 | Shipping Cost Data | Interview | PT X Staff |

**Identification of *Matrix* Distance**

In the first stage, know the distance from the warehouse to the destination store and the distance between the interconnected stores. To simplify the problem, we can choose the shortest path as the distance between locations.

**Identify Savings *Matrix***

At this second stage, it is assumed that each store is visited by the truck exclusively. So there are savings that occur if many routes are combined into one route. The *Saving matrix* will make this savings possible by combining many stores into using only one route.

If the stores are visited separately (not together), the distance travelled is the distance from the company's warehouse to store I and from the store I back to the company's warehouse plus the distance from the company's warehouse to store two and then back to the warehouse. The formula would be:

$$S(x, y) = J(G, x) + J(G, y) - (J(x, y) \quad (1)$$

**Allocating Stores to Vehicles or Routes**

In the third stage, the stores are divided into travel routes that consider the stores and vehicle capacity. If the total volume of all stores does not exceed the vehicle capacity, then one route is said to be *feasible,* and the total volume of a store can be accommodated as a whole by a vehicle.

**Sorting Stores in a Defined Route**

In this fourth stage, the order of visits is determined. This stage has the principle that the order of these visits minimizes the distance travelled by the vehicle.

Here are some methods commonly used in determining the order of visits:

a. Farthest Insert Method

This method principle adds customers to a travel route, increasing the distance to the most significant or most distant. This principle will continue to be carried out until all consumers enter the route.

b. Nearest Insert Method

This method is a method Farthest insert opposite where this procedure starting from the determination of these vehicles to consumers who have the closest distance. Then this procedure will continue to repeat until all consumers enter the route.

c. Farthest Insert Method

The principle of using the nearest neighbour method to sort store visits is to start with the warehouse and then add the stores closest to the warehouse. The existing route is constructed at each stage by adding the store closest to the last visited store.

## RESULT and DISCUSSION

### Data Collection

**A. Distance of Collecting Station (CS) with Warehouse**

The data distance between the collection station and the warehouse is shown in Table 2.

Table 2. Distance from Collecting Station to Warehouse

| No. | Collecting Station (CS) | Distance to the warehouse (km) |
|---|---|---|
| 1 | Tambun Collecting Station | 217 |
| 2 | PDT Collecting Station | 220 |
| 3 | RDL Collecting Station | 212 |
| 4 | PDM Collecting Station | 220 |

In addition to the warehouse, PT X Tambun Field (CS Tambun) distributes materials that users will use to several CS. Table 3 shows the destinations and their distances.

Table 3 Distance from CS Tambun to other SP

| No. | Collecting Stations (CS) | Distance to the warehouse (km) |
|---|---|---|
| 1 | PDT Collecting Station | 14 |
| 2 | RDL Collecting Station | 49 |
| 3 | PDM Collecting Station | 17 |

**B. Data on Distance Between Collecting Station (CS) and Transport Capacity**

Data on the distance between one collecting station and another collecting station is shown in Table 4.

Table 4 Distance from CS Tambun to other CS

| | TB CS | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|
| TB CS | 0 | | | |
| PDT CS | 14 | 0 | | |
| RDL CS | 49 | 44,9 | 0 | |
| PDM CS | 17 | 12,4 | 32,9 | 0 |

Distance data from PT X Tambun Field (Tambun CS) to another collecting station is shown in Table 5.

Table 5 Distance between other collection stations in km

| | PDT CS | RDL CS | PDM CS |
|---|---|---|---|
| PDT CS | 0 | | |
| RDL CS | 44,9 | 0 | |
| PDM CS | 12,4 | 32,9 | 0 |

Following data on the Transport Capacity of each collecting station is shown in Table 6.

Tabel 6 Data on Collecting Stations and Transport Capacity (Tons)

| No | Collecting Stations (CS) | Transport Capacity (Tons) |
|---|---|---|
| 1 | Tambun Collecting Station | 10 |
| 2 | PDT Collecting Station | 20 |
| 3 | RDL Collecting Station | 10 |
| 4 | PDM Collecting Station | 10 |

Following data on the Transport Capacity of each collecting station is shown in Table 7 if the shipment is made from PT X to the Collecting Station Other:

Table 7 Data on Storage and Transport Capacity (Tons) Collecting

| No | Collecting Stations (CS) | Transport Capacity (Tons) |
|---|---|---|
| 1 | PDT Collecting Station | 15 |
| 2 | RDL Collecting Station | 15 |
| 3 | PDM Collecting Station | 10 |

## C. Data of Transport Equipment and Transport Equipment Capacity

Table 8 shows the list of tools used to transport materials used by users:

Table 8. Data of Transport Equipment and its Capacity

| Jenis Kendaraan | Jumlah (Unit) | Kapasitas (Ton) | Performance (Minimal) | Rentang Jarak/Trip (Km) | Tarif Trip PP Total (Rp) | Jumlah Trip | Biaya | Keterangan |
|---|---|---|---|---|---|---|---|---|
| Trailer (Prime Mover + Trailer High Bed) | 4 | 40 | 85% | 0-25 | 1.850.000,00 | 30 | 55.500.000,00 | High Bed Trailer min 12 m c/w Prime Mover 320 HP, Tahun 2015 ke atas |
| | | | | 26-50 | 2.400.000,00 | 5 | 12.000.000,00 | |
| | | | | 51-75 | 2.800.000,00 | 15 | 42.000.000,00 | |
| | | | | 76-100 | 3.500.000,00 | 5 | 17.500.000,00 | |
| | | | | 101-125 | 4.200.000,00 | 5 | 21.000.000,00 | |
| | | | | 126-150 | 4.600.000,00 | 9 | 41.400.000,00 | |
| | | | | 151-175 | 5.700.000,00 | 21 | 119.700.000,00 | |
| | | | | 176-200 | 6.200.000,00 | 5 | 31.000.000,00 | |
| | | | | 201-225 | 7.000.000,00 | 9 | 63.000.000,00 | |
| | | | | 226-250 | 7.700.000,00 | 85 | 654.500.000,00 | |
| | | | | MOB-DEMOB | 5.000.000,00 | 94 | 470.000.000,00 | |
| Trailer (Prime Mover + Trailer Low Bed) | 1 | 40 | 85% | 0-25 | 2.300.000,00 | 2 | 4.600.000,00 | Low Bed Trailer min 10 m c/w Prime Mover 320 HP, Tahun 2015 ke atas |
| | | | | 26-50 | 2.800.000,00 | 2 | 5.600.000,00 | |
| | | | | 51-75 | 3.500.000,00 | 5 | 17.500.000,00 | |
| | | | | 76-100 | 4.400.000,00 | 2 | 8.800.000,00 | |
| | | | | 101-125 | 5.000.000,00 | 2 | 10.000.000,00 | |
| | | | | 126-150 | 5.600.000,00 | 2 | 11.200.000,00 | |
| | | | | 151-175 | 6.400.000,00 | 2 | 12.800.000,00 | |
| | | | | 176-200 | 7.000.000,00 | 2 | 14.000.000,00 | |
| | | | | 201-225 | 7.800.000,00 | 2 | 15.600.000,00 | |
| | | | | 226-250 | 8.500.000,00 | 4 | 34.000.000,00 | |
| | | | | MOB-DEMOB | 5.000.000,00 | 6 | 30.000.000,00 | |

## Data Processing

### A. Identification of Distance Matrix

The initial step that is carried out in the saving matrix is to minimize traffic; the distance is to identify the matrix distances follows can be seen in table 9.

Table 9. Matrix Distance between Collecting Station and Warehouse (Km)

| | W | TB CS | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|---|
| TB CS | 217 | 0 | | | |
| PDT CS | 220 | 14 | 0 | | |
| RDL CS | 212 | 49 | 44,9 | 0 | |
| PDM CS | 220 | 17 | 12,4 | 32,9 | 0 |

Then, identify the distance matrix as follows if PT X Tambun Field delivery can be seen in table 10.

Table 10. Matrix Distance between Collecting Station and Warehouse (Km)

| | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|
| TB CS (W) | 0 | | | |
| PDT CS | 14 | 0 | | |
| RDL CS | 49 | 44,9 | 0 | |
| PDM CS | 17 | 12,4 | 32,9 | 0 |

### B. Identification of the Savings Matrix

the savings matrix formula is as follows:

S(x,y)= J(G,x)+J(G,y)-J(x,y) (2)

The above formula can be seen in the distance saving matrix from all the Collecting Stations (CS) to be visited. For example, you can see the calculation matrix following savings:

Savings Matrix Calculation of CS Tambun and CS PDT

S(TB,PDT)= J(W,TB)+J(W,PDT)-J(TB,PDT)

S(TB,PDT)= 217+220-14

S(TB,PDT)= 423

Matrix of savings for each other Collecting Station (CS), can be seen in table 11.

Table 11 Matrix of Spatial Savings

| | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|
| TB CS (W) | 0 | | | |
| PDT CS | 14 | 0 | | |
| RDL CS | 49 | 44,9 | 0 | |
| PDM CS | 17 | 12,4 | 32,9 | 0 |

So, the matrix savings result is shown in Table 12.

Table 12 Matrix Savings Distance (Tambun CS)

| | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|
| TB CS (W) | 0 | | | |
| PDT CS | 14 | 0 | | |
| RDL CS | 49 | 44,9 | 0 | |
| PDM CS | 17 | 12,4 | 32,9 | 0 |

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### C. Allocating Collecting Station Results (CS) to Transportation Routes

The next step is to determine the initial route, which is a separate route that each mode of transportation will visit. See Table 13 for the initial transportation route.

Table 13 Initial Routes for Each Collecting Station (CS)

| | W | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|---|
| TB CS (W) | Route 1 | 0 | | | |
| PDT CS | Route 2 | 14 | 0 | | |
| RDL CS | Route 3 | 49 | 44,9 | 0 | |
| PDM CS | Route 4 | 17 | 12,4 | 32,9 | 0 |
| Order | | 10 | 20 | 10 | 10 |

Table 13 shows that each CS and CS were allocated to a different route in the initial routes, so in the initial route, there were four routes. However, CS can be combined until it reaches the limit of the available conveyance capacity.

Merger starts from the value of the most significant savings due to maximizing savings. Then starting from 427.6 Km, the most significant savings from combining PDM CS and PDT CS are shown in table 14.

Table 14 Matrix of First Step Savings

| | W | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|---|
| TB CS | Route 1 | 0 | | | |
| PDT CS | Route 2 | 423 | 0 | | |
| RDL CS | Route 3 | 380 | 387,1 | 0 | |
| PDM CS | Route 4 | 420 | 427,6 | 399,1 | 0 |
| Order | | 10 | 20 | 10 | 10 |

In table 14, it can be seen that the total load of PDM CS is 20 tons and the total load of PDT CS is 10 tons so that the merger is feasible because it is smaller than the capacity of the conveyance. The routes for PDM CS and PDT CS are combined into route 2. The total load for route 2 becomes 20 + 10 = 30 Tons.

The following combination is the second-largest saving value, 423 km, which is the most significant saving from combining PDT CS with TB CS, as shown in table 15.

Table 15 Matrix of Second Step Savings

| | W | TB CS (W) | PDT CS | RDL CS | PDI CS |
|---|---|---|---|---|---|
| TB CS | Route 1 | 0 | | | |
| PDT CS | Route 2 | 423 | 0 | | |
| RDL CS | Route 3 | 380 | 387,1 | 0 | |
| PDM CS | Route 4 | 420 | 427,6 | 399,1 | 0 |
| Order | | 10 | 20 | 10 | 10 |

In table 14, it can be seen that the total load of PDT CS is 10 tons, and the total load is TB CS is 10 tons so that the merger is feasible because it is smaller than the capacity of the conveyance. The routes for PDT CS and TB CS are combined into route 2. The total load for route 1 becomes 10 + 10 = 20 Tons.

The following combination is the value of the second-largest saving, 420 km, which is the most significant savings from combining PDM CS with TB CS, as shown in table 16.

Table 16 Matrix of Third Step Savings

| | W | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|---|
| TB CS | Route 1 | 0 | | | |
| PDT CS | Route 2 | 423 | 0 | | |
| RDL CS | Route 3 | 380 | 387,1 | 0 | |
| PDM CS | Route 4 | 420 | 427,6 | 399,1 | 0 |
| Order | | 10 | 20 | 10 | 10 |

In table 16, it can be seen that the total load of PDM CS is 10 tons, and the total load is TB CS is 10 tons so that the merger is feasible because it is smaller than the capacity of the conveyance. The routes for PDM CS and TB CS are merged into route 1 with PDT CS. The total load for route 1 becomes 10 + 20 + 10 = 40 Tons.

Any routes that no longer exist can be added, so further merging is impossible. Then there are two routes generated by the merge step based on the preservation matrix method. The result of the merger is shown in Table 17.

Table 17 Merger Results of the Method Saving Matrix

| Route | Collecting Station | Total capacity (tons) | Total Load Capacity (Tons) |
|---|---|---|---|
| 1 | Tambun CS | 10 | 40 |
| | PDT CS | 20 | |
| | PDM CS | 10 | |
| 2 | RDL CS | 10 | 10 |

The next step is to establish the route, a separate route that each vehicle will visit. The initial transportation route if delivery is via PT X Tambun Field can be seen in table 18.

Tabel 18 Initial route for each CS from Tambun CS

| | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|
| PDT CS | Route 1 | 0 | | |
| RDL CS | Route 2 | 18,1 | 0 | |
| PDM CS | Route 3 | 18,6 | 53,6 | 0 |
| Order | | 15 | 15 | 10 |

Based on table 19, each Collecting Station (CS) is allocated to the transportation route. Each CS and CS are allocated to a different route in the initial route, so in the initial route, there are three routes. However, CS can be combined up to the limit of the available conveyance capacity.

Table 19 Matrix First Step Savings from Tambun CS

| | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|
| PDT CS | Route 1 | 0 | | |
| RDL CS | Route 2 | 18,1 | 0 | |
| PDM CS | Route 3 | 18,6 | 53,6 | 0 |
| Order | | 15 | 15 | 10 |

Table 20 Initial Route for Each CS from Tambun CS

| | TB CS (W) | PDT CS | RDL CS | PDM CS |
|---|---|---|---|---|
| PDT CS | Route 1 | 0 | | |
| RDL CS | Route 2 | 18,1 | 0 | |
| PDM CS | Route 3 | 18,6 | 53,6 | 0 |
| Order | | 15 | 15 | 10 |

Subsequent mergers have not been possible to do because each route can not be added or combined. Then there is one route generated by the merging step based on the preservation matrix method. The results of the merger are shown in Table 21.

Table 21 Merger Results of The Saving Matrix Method

| Route | Collecting Station | Total Capacity (tons) | Total Load Capacity (Tons) |
|---|---|---|---|
| 1 | PDT CS | 15 | 40 |
| | RDL CS | 15 | |
| | PDM CS | 10 | |

**D. Sorting the Collecting Stations (SP) in the Route Already Defined**

From the routes that have been obtained in tables 15 and 19, the next step is to sort the collecting stations into a defined route to determine the order of collecting stations that must be visited on a route. In sorting it using the following three methods:

- Sorting the Collecting Stations (CS) with the Nearest Insert Method

The route calculated is only routed because it goes through several SP CS, Tambun CS, PDT CS, and PDM CS, while for route 2 it is unnecessary to sort using the Nearest Insert method. Table 22 shows the order of CS for Route 1.

Table 22 Distance between Collecting Stations and Warehouse Route 1 (km)

| CS | Warehouse | TB CS | PDT CS | PDM CS |
|---|---|---|---|---|
| Warehouse | 0 | 217 | 220 | 220 |
| TB CS | | 0 | 14 | 17 |
| PDT CS | | | 0 | 12,4 |
| PDM CS | | | | 0 |

Distance W – PDT CS – W = 217 + 217 = 434
Distance W – PDT CS – W= 220 + 220 = 440
Distance W – PDM CS – W = 220 + 220 = 440

Since the smallest distance is 434 km from the three alternatives, the first is the Tambun Collecting Station (CS). The following collection station (CS) visited is as follows:

Distance W – TB CS – PDT CS – G = 217 + 14 + 220 = 451

Distance W – TB CS – PDM CS – G = 217 + 17 + 220 = 454

Because the minimum is the first alternative with a distance of 451 Km. So the one who visited after Tambun CS was PDT CS. The route sequence obtained for route 1 is W-TB CS-PDT CS-PDM CS-W

The route calculated is only routed because it goes through several CS, PDT CS, RDL CS, and PDM CS. Table 23 shows the order of CS for Route 1.

Table 23 Distance between CS and Tambun CS Route 1 (km)

| CS | Warehouse | TB CS | PDT CS | PDM CS |
|---|---|---|---|---|
| Warehouse | 0 | 14 | 49 | 17 |
| TB CS | | 0 | 44,9 | 12,4 |
| PDT CS | | | 0 | 32,9 |
| PDM CS | | | | 0 |

Distance TB CS – PDT CS – TB CS = 14 + 14 = 28

Distance TB CS – RDL CS – TB CS = 49 + 49 = 98

Distance TB CS – PDM CS – TB CS = 17 + 17 = 34

Due to the distance, the minimum is 28 km from the three alternatives, so the first thing to visit is the PDT Collecting Station (CS). The following collection station (CS) visited is as follows:

Distance TB CS – PDT CS – RDL CS – TB CS = 14 + 44.9 + 49 = 107.9

Distance TB CS – PDT CS – PDM CS – TB CS = 14 + 12.4 + 17 = 43.4

Because the minimum is the second alternative with a distance of 43.4 Km. So the one who visited after PDT CS was PDM CS. The route sequence obtained for route 1 is TB CS-PDT CS-PDM CS-RDL CS-TB CS.

- Sorting the Collecting Stations (CS) with the Nearest Neighbor Method

The calculated route is only routed one because it goes through several SP, namely Tambun CS, PDT CS, and PDM CS, while route two does not need to be sorted using the Nearest Neighbor method.

Among the three collecting stations (CS) closest to the warehouse is Tambun CS, with 217 Km. Then the closest distance from Tambun CS is PDT CS with 14 Km, and the distance from PDT CS to PDM CS is 12.4 Km. So the resulting route sequence for route 1 is W-Tambun CS-PDT CS-PDM CS-W.

As for Route 1 with delivery from Tambun CS through several CS, namely PDT CS, RDL CS, and PDM CS, following the order:

Among the 3 Collecting Stations (CS) closest to Tambun CS is PDT CS with a distance of 14 Km. Then the closest distance from PDT CS is PDM CS with 12.4 Km, and the distance from PDT CS to RDL CS is 32.9 Km. So the resulting route sequence for route 1 is TB CS-PDT CS-PDM CS-RDL CS-TB CS.

- Sorting Collecting Stations (SP) to the Farthest Insert Method

Farthest Insert Method is run by entering the Collecting Stations (CS), which indicate the route farthest. Calculations for each route are shown in table 24.

Table 24 Comparison of Route Sequence Results with 3 Methods

| Route | Method | Sequence | Total Distance (km) |
|---|---|---|---|
| 1 | Nearest Insert | W – TB CS – PDT CS – PDM CS– W | 217 + 14 + 12,4 + 220 = 463,4 |
| | Nearest Neighbor | W – TB CS – PDT CS – PDM CS – W | 217 + 14 + 12,4 + 220 = 463,4 |
| | Farthest Insert | W – TB CS – PDT CS – PDM CS – W | 220 + 12,4 + 17 + 217 = 466,4 |
| 2 | - | W –RDL CS – W | 217 + 212 = 424 |

## E. Comparison of Initial and Proposed Route Distance

Tables 25 and 26 show the distance comparison initial route and proposed route

Table 25 Total Initial Route Distance

| No. | Route Traversed | Total Distance (km) |
|---|---|---|
| 1 | Warehouse – Tambun CS – Warehouse | 217 + 217 = 434 |
| 2 | Warehouse – PDT CS – Warehouse | 220 + 220 = 440 |
| 3 | Warehouse – RDL CS – Warehouse | 212 + 212 = 424 |
| 4 | Warehouse – PDM CS – Warehouse | 220 + 220 = 440 |
| Total | | 1738 |

Table 26 Total Distance of Proposed Route

| No | Route Traversed | Total Distance (km) |
|---|---|---|
| 1 | W – TB CS – PDT CS – PDM CS – W | 217 + 14 + 12,4 + 220 = 463,4 |
| 2 | W – RDL CS – W | 212 + 212 = 424 |
| Total | | 887,4 |

Based on tables 25 and 26, there are distance savings from the total distance of the initial route and the total distance of the suggested route. So the distance savings can be calculated as follows:

The efficiency of mileage = $\frac{total\ initial\ route\ distance - total\ proposed}{total\ initial\ route\ distance}\ x\ 100\%$

= $\frac{1738-887,4}{1738}\ x\ 100\%$

= $0,4894\ x\ 100\%$

= $48,94\%$

Meanwhile, for PT X Tambun Field shipments, the distance comparison is shown in tables 27 and 28.

Tabel 27 Total Initial Route Distance (Tambun CS)

| No. | Route Traversed | Total Distance (km) |
|---|---|---|
| 1 | TB CS – PDT CS – TB CS | 14 + 14 = 28 |
| 2 | TB CS – RDL CS – TB CS | 49 + 49 = 98 |
| 3 | TB CS – PDM CS – TB CS | 17 + 17 = 34 |
| Total | | 160 |

Table 28 Total Distance Proposed Route

| No. | Route Traversed | Total Distance (km) |
|---|---|---|
| 1 | TB CS– PDT CS – PDM CS – RDL CS – TB CS | 14 + 12,4 + 32,9 + 49 = 108,3 |

Based on tables 27 and 28, it can be seen that both the total distance of the initial route and the total distance of the suggested route have distance savings. So the distance savings can be calculated as follows:

The efficiency of mileage = $\frac{total\ initial\ route\ distance - total\ proposed}{total\ initial\ route\ distance}\ x\ 100\%$

= $\frac{160-108,3}{160}\ x\ 100\%$

= $0,3231\ x\ 100\%$

= $32,31\%$

## F. Travel Time Calculation

It is assumed that the speed of the transportation equipment used by PT X Tambun Field is 60 km/hour and 80 km/hour. So,

Initial route time = $\frac{1738\ km}{60\ km.hour} = 28.97$ hours

Proposed route time = $\frac{887,4\ km}{60\ km.hour} = 14.79$ hours

Initial route time = $\frac{1738\ km}{80\ km.hour} = 21.73$ hours

Proposed route time = $\frac{887,4\ km}{80\ km.hour} = 11.09$ hours

Meanwhile, the initial route time and the proposed delivery route time from SP Tambun are calculated as follows:

Initial route time = $\frac{160\ km}{60\ km.hour} = 2,7$ hours

Proposed route time = $\frac{108,3\ km}{60\ km.hour} = 1,08$ hours

Initial route time = $\frac{160km}{80\ km.hour} = 2$ hours

Proposed route time = $\frac{108,3\ km}{80\ km.hour} = 1,4$ hours

So that efficiency can be determined:

Efficiency initial route travel time (60 km/hour) = $\frac{total\ initial\ route\ time - total\ route\ time\ proposed}{total\ initial\ route\ time}\ x\ 100\%$

= $\frac{28.97-14.79}{28.97}$ =48.95%

The efficiency of initial route travel time (80 km/hour)

$$= \frac{total\ initial\ route\ time - total\ proposed}{total\ initial\ route\ time} x\ 100\%$$

$$= \frac{21.73 - 11.09}{21.73} = 48.96\%$$

While the efficiency of time for delivery from SP Tambun is as follows:

The efficiency of initial route travel time (60 km/hour)

$$= \frac{total\ initial\ route\ time - total\ route\ time\ proposed}{total\ initial\ route\ time} x\ 100\%$$

$$= \frac{2.7 - 1,08}{2.7} = 60\%$$

The efficiency of initial route travel time (80 km/hour)

$$= \frac{total\ initial\ route\ time - total\ proposed}{total\ initial\ route\ time} x\ 100\%$$

$$= \frac{2 - 1,4}{2} = 30\%$$

### G. Calculation of Transport Cost Efficiency or Transport Equipment Rental The

Following is a calculation of transport cost efficiency:

Initial route cost efficiency (Trailer (Prime Mover + Trailer High Bed)

$$= \frac{\text{total initial route cost} - \text{total route cost proposed}}{\text{total initial route cost}} \text{x } 100\%$$

$$= \frac{56{,}000{,}000.00 - 31{,}70{,}000.00}{56{,}000{,}000.00} = 43.39\%$$

Efficiency initial route travel time (Trailer (PrimeMover + Trailer HighBed)

$$= \frac{\text{the total cost of these early} - \text{total costs of these proposals}}{\text{the total cost of the initial}} \text{x } 100\%$$

$$= \frac{62{,}400{,}000.00 \text{ to } 35{,}800{,}000.00}{62\ 400\ .000{,}00} = 42.63\%$$

Meanwhile, the initial route time and the proposed delivery route time from the warehouse are calculated as follows:

Initial route cost efficiency (Trailer (Prime Mover + Trailer High Bed)

$$= \frac{\text{total initial route cost} - \text{total route cost proposed}}{\text{total initial route cost}} \text{x } 100\%$$

$$= \frac{12{,}200{,}000.00 - 8{,}500{,}000.00}{12{,}200{,}000.00} = 30.32\%$$

Efficiency of initial route travel time (Trailler (Prime Mover + Trailler High Bed)

$$= \frac{\text{total initial route cost} - \text{total cost of the proposed route}}{\text{total initial route cost}} \text{x } 100\% =$$

$$\frac{14.80.000{,}00 - 10.200.000{,}00}{14.800\ .000{,}00} = 31.08\%$$

## CONCLUSION

1. Following are the research conclusions conducted at PT X Tambun of 1738 km if delivery is from warehouse and three routes if delivery is from PT X Tambun Field (Tambun Collector Station) with 160 km.
2. The warehouse's proposed distribution route from the warehouse resulted in 2 routes with distance savings of 48.94% and saving on rental costs (trailer prime Mover + Trailer High Bed) by 43.39% and Trailer transportation equipment (Prime). Mover + Trailer Low Bed) of 42.63%.
3. The proposed distribution route for delivery from PT X Tambun Field (Tambun Collector Station) resulted in 1 route with a distance savings of 32.31% and a 30.32% reduction in the cost of renting transportation equipment (trailer prime Mover + Trailer High Bedtrailer) and for transportation. (Prime Mover + Trailer Low Bed) of 31.08%.
4. The initial distribution route for shipments from the warehouse results in a travel time savings of 48.95% if the speed is assumed to be 60 km/hour and 48.96% if the speed is assumed to be 80 km/hour.
5. The initial distribution route for shipments from the warehouse results in a travel time savings of 60.00% if the speed is assumed to be 60 km/hour and 30.00% if the speed is assumed to be 80 km/hour.

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