Improving the Efficiency of the Milkrun Truck Suppliers in Cikarang Area by Merging the Payload Cycles and Optimizing the Milkrun Route Using the Saving Matrix Methods

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Abstract. The declining in people's purchasing power on motor vehicles has a direct impact on the manufacturing industry as a supplier of automotive companies. It is necessary, therefore, to do savings on each side of the company's operations, one of which is the transportation cost. The condition of Cikarang milkrun lorry load with 7 suppliers is not optimal yet, where the cycle 1 is only 70%, and the cycle 2 is only 50% of the total truck capacity. Based on this situation, it’s urgent to merge the truckloads of the milkrun cycle 1 and 2 in order to have savings in terms of transportation cost. The insufficiency of the truck capacity to accommodate the total load of the merged capacity of the cycle 1 and 2, is necessary to be analyzed and refined in term of the palette pattern. The status in the palette pattern of the supplier company should be improved. The supplier can be called independent while the payload is at least of 2 pallets. The optimizing of the milkrun truck capacity is expected to support the merging of milkrun truckloads of the cycle 1 and 2 in term of the transportation cost savings. Furthermore, the rerouting of the milkrun is determined by using saving matrix method. The impact of the reduced milkrun mileage is expected to be an alternative to reduce the cost of transporting milkrun per trip.

1. Introduction
PT. Denso as a manufacturing company (vehicle components), pushing the system of procurement and delivery of raw materials from suppliers to production plants to be very effective and efficient. The more effective and efficient the system will directly accelerate the production line and the subsequent processes so as to overcome the lack of raw materials, the delay and even the cessation of production. Effective and efficient system of procurement and delivery of raw materials will also reduce the cost of production and will also increase the company's profit.

Transportation costs ranging from one-third to two-thirds of the total logistics cost (Ballou, 2004), the increased efficiency in transport utilization maximally greatly reduces cost expenditure.

PT. Denso use milkrun transportation system used to pick up raw materials from suppliers. The milkrun system in PT Denso, has provided more savings compared to using the conventional transport system in the past.

The technique used to schedule a limited number of vehicles to deliver their goods to consumers by minimizing the distance is the saving matrix. This method not only uses the distance as a parameter, but
also the capacity of the conveyance to obtain the greatest savings value for the subsequent arrangement into the best route.

2. Literature Review

2.1. Cycle Issue
According to Monden (2000), the cycle issue is the frequency of delivery of goods by suppliers. Factors that influence in determining cycle issues such as supplier distance, characteristics and variants of components supplied, the number of orders per day and truck capacity.

2.2 Transportation Systems
Transportation is the activity of moving raw materials and finished goods to customer or consumers. A good transportation system from a company will have a positive impact for the company, that is: a. Increase business competitiveness b. Transport cost savings c. Suppressing product selling price

2.2.1 Milkrun Transport System
The milkrun transport system is a system of transporting / retrieving components from a number of suppliers using a single vehicle and at the same time an empty box is returned to the supplier (Lisa Froehlich, 1999).

![Figure 1. Milkrun Systems](image)

The benefits of the milkrun concept are:
- Shorten travel distance
- Increase vehicle load efficiency
- Reduce the number of vehicles used
- More efficient scheduling
- Significantly reduced emissions and energy use.

2.2.2 Saving Matrix Method
According to Faiz (2013), the steps of saving matrix method are as follows:
1. Determining the distance matrix
2. Determining the value of saving matrix
3. Allocate suppliers to a distribution route.
4. Sort the route of taking raw materials.
Ordering of raw materials to suppliers is done using nearest insert, farthest insert and nearest neighbor procedures.
The most optimal route is the route taken with the shortest distance.
2.3. Truck Types and Capacity & Fuel Ratio

There are various types of land transportation modes today, one of which is a truck.

Table 1. Truck Types & Capacity

| No | Types of Truck | Capacity | Fuel Ratio/1lt |
|----|----------------|----------|---------------|
| 1  | Truk Engkel 100PS - 110PS | 6 | 2 | 7.5 |
| 2  | Truk Double 6 km 110PS - 120PS | 12 | 5 | 6 |
| 3  | Truk Engkel 140PS - 235PS | 25 | 8 | 4 |
| 4  | Truk Triton 235PS - 260PS | 55 | 15 | 3 |

2.4 Framework for Thinking

3. Research Methods

3.1. Modes, Status & Transportation Capacity of Milkrun in Cikarang

Distance from Sunter to Cikarang is about 43 km, the mode of transportation used is a truck using 190PS - 235PS truck with truck capacity of 25 M³ or 8 tons.

Trucks used by PT. Denso as a transport of milkrun in Cikarang, the status is rent for each cycle PT. Denso paid Rp. 938,000, - PT. Denso has palette placement is 120 cm. So the standard load in the truck can be stacked two.
3.2. The Condition of Truckloads

The load of milkrun truck Cikarang area becomes less optimal for cycle 1 or cycle 2. The unoptimal condition of milkrun truck load for Cikarang area of cycles 1 and 2 can be seen in figure 3 & 4.

![Figure 3. The Milkrun Truck Load Cycle 1](image1)

![Figure 4. The Milkrun Truck Load Cycle 2](image2)

3.3. The Mileage Distribution of the Milkrun Trucks

| No | Supplier | Address |
|----|----------|---------|
| 1  | PT. Trawi | Desa Nagrang, Kab. Bekasi, Kawasan Industri Terpadu (KHTC) |
| 2  | PT. Yanaou  | Ruko Imp 1 Blok C1 No.17, Cikarang Selatan, Cikarang, Bekasi |
| 3  | PT. Nosirat | Delta Silver Industrial Park, Jalan Atasik 3 Blok A5 No.8, Sukarema, Cikarang Selatan |
| 4  | PT. CNC   | Jl. Anggrek 2 Blok A4 No.25, Sukarema, Cikarang Selatan, Bekasi |
| 5  | PT. Suryabina | Jl. Anggrek 3 Blok A1 No.59, Sukarema, Cikarang Selatan, Bekasi |
| 6  | PT. Yamin  | BRI Industrial Park, Blok 0C/A1-A2, Jl. Ujiang, Desa Sukarema, Cikarang Selatan, Serang |
| 7  | PT. Sugiyana | Kawasan GIC Blok C1 Nomor 10, Pasimenji, Cikarang Bpec, Pasimenji, Cikarang, Bekasi |

To explain the distribution distance, the supplier’s name is converted into codes making it easier and succinct to explain. Codes from each supplier can be seen in table 4.2.
Table 3. Supplier Code for Cikarang area

| Supplier Code | Suppliers  | Code |
|---------------|------------|------|
| PT. Denso (Sunter) - DN | PT. Triwall | A |
|               | PT. Yamakou | B |
|               | PT. Nesina | C |
|               | PT. CNC    | D |
|               | PT. Suryatitiia | E |
|               | PT. Yamani | F |
|               | PT. Sugiyama | G |

Once the supplier's address and code are created, to make it easier to imagine the position of each supplier in the Cikarang area, it is depicted in a map in Figure 5.

![Figure 5. Map of Supplier Location in Cikarang Area](image)

Table 4. Distance Distribution of Milkrun Truck (Km)

|       | DN | A   | B   | C   | D   | E   | F   | G   |
|-------|----|-----|-----|-----|-----|-----|-----|-----|
| DN    | 0  | 59.1| 50.3| 51.1| 51  | 51.1| 54.4| 60.3|
| A     | 0  | 14.9| 16.8| 16.4| 16.9| 13.6| 4.9 |     |
| B     | 0  | 3.6 | 3.6 | 3.7 | 3.2 |     |     |     |
| C     | 0  | 1   | 1.1 | 1.1 | 1.8 |     |     |     |
| D     | 0  | 0.4 | 12.4| 17.8|     |     |     |     |
| E     | 0  | 12.5|     |     |     |     |     |     |
| F     | 0  | 14.8|     |     |     |     |     |     |
| G     | 0  |     |     |     |     |     |     |     |

Based on Table 4, the distance from Denso to each supplier and the distance between the suppliers themselves. Therefore, the mileage of milkrun cikarang trucks for each cycle can be known by combining route data of Cikarang milkrun. Total mileage of truck milkrun Cikarang area can be seen in table 5.

![Table 5. Total Mileage of Truck Milkrun Cikarang Area](image)
4. Results and Analysis

4.1 Pallet Pattern of the Suppliers for Cikarang area

The current condition of the milkrun truckload is only 70% of the truck's capacity, cycle 1, then the cycle 2 is only 50% of the truck's capacity. The desire to cut cycle by combining the Cikarang milkrun lorry cycles 1 and 2 is based on this condition.

The maximum total capacity of the current milkrun truck is 10 pallets while combining the payload cycle 1 and 2, then the total is 12 pallets.

4.2 The Reduction of Milkrun Cycle Issue for Cikarang Area

The truckload of milkrun trucks in Cikarang Region that is not optimal is a potential and opportunity to make savings in terms of transportation costs by reducing the cycle issue. The previous cycle of milkrun in Cikarang area is 2 cycles / day, now the target after the reducing is 1 cycle / day.

4.3 Transport Cost Saving Calculations

The cost savings can be calculated by: Total Savings (C) = Cost of Transportation Saving (A) - Procurement Cost & Maintain Outer Box (B)

A. Cost of Transportation Saving

The reduction of the cycle issue had an impact on transportation costs. The cost of transport savings can be calculated by New Transportation Cost

- The Proposed Transportation Costs
  In the calculation of new transportation costs, cycle of goods picking on Saturday and Sunday calculated which the total in 1 month is 8 cycle of taking goods. So the total day of picking of goods to 28 days / month. - Cost / day: Rp. 938,000 x 1 = Rp. 938,000 - Cost / month: Rp 938,000 x 20 = Rp. 18.76 million - Cost / year: Rp. 18.760.000 x 12 = Rp. 225.120.000

- The Cost of Transportation Saving
  The the total cost of transportation of milkrun in Cikarang area is Rp. 450,240,000 - Rp. 225.120.000 = Rp. 225,120,000, - / year.

B. Cost of Procurement & Maintenance of Outer Box

The total initial procurement of the outer box is 6 pcs. So the total cost is Rp. 1.260,000, - / month. The re-procurement outer box is done after the use of 10x trip delivery.

The total additional expenses incurred during 1 year for procurement and maintenance outer box is Rp. 15.120.000, -

C. The Total of Savings

The total transportation cost savings can be calculated with Transportation Saving Cost (A) - Procurement Cost & Maintainance of the Outer Box (B). Total savings: Rp. 225,120,000 - Rp. 15.120.000 = Rp. 210.00.000, -.

| Cycle | Route | Mileage |
|-------|-------|---------|
| 1     | DN -> A -> B -> C -> D -> E -> F -> DN | 145.9 |
| 2     | DN -> C -> G -> DN | 129.4 |
| Total Jarak Tempuh | 275.3 |

Table 5. Milkrun Mileage in Cikarang area for Each Cycle (Km)
4.4 Saving Matrix Analysis

Table 6. Calculation of Supply Chain

| Mileage Saving | Formula       | Results |
|----------------|---------------|---------|
| S(A,B)         | 59.1 + 50.3 – 14.9 | 94.5   |
| S(A,C)         | 59.1 + 51.1 – 16.8 | 93.4   |
| S(A,D)         | 59.1 + 51 – 16.4  | 93.7   |
| S(A,E)         | 59.1 + 51.1 – 16.9 | 93.3   |
| S(A,F)         | 59.1 + 54.4 – 13.6 | 99.9   |
| S(A,G)         | 59.1 + 60.3 – 4.9  | 114.5  |
| S(B,C)         | 50.3 + 51.1 – 3.6  | 97.8   |
| S(B,D)         | 50.3 + 51 – 3.6    | 97.7   |
| S(B,E)         | 50.3 + 51.1 – 3.7  | 97.7   |
| S(B,F)         | 50.3 + 54.4 – 3.2  | 101.5  |
| S(B,G)         | 50.3 + 60.3 – 17.2 | 93.4   |
| S(C,D)         | 51.1 + 51 – 1      | 101.1  |
| S(C,E)         | 51.1 + 51.1 – 1.1  | 101.1  |
| S(C,F)         | 51.1 + 54.4 – 2.6  | 102.9  |
| S(C,G)         | 51.1 + 60.3 – 18   | 93.4   |
| S(D,E)         | 51 + 51.1 – 0.4    | 101.7  |
| S(D,F)         | 51 + 12.4 – 12.4   | 51     |
| S(D,G)         | 51 + 60.3 – 17.8   | 93.5   |
| S(E,F)         | 51.1 + 54.4 – 12.5 | 93     |
| S(E,G)         | 51.1 + 60.3 – 17.9 | 93.5   |
| S(F,G)         | 54.4 + 60.3 – 14.8 | 99.9   |

Based on the calculation of distance saving, it is necessary to describe the saving matrix to be easily understood. The cost savings matrix of each supplier is illustrated in Table 7

Table 7. Mileage-Saving Matrix

| Suppliers | A   | B   | C   | D   | E   | F   | G   |
|-----------|-----|-----|-----|-----|-----|-----|-----|
| A         | 0   | 94.5| 93.4| 93.7| 93.3| 99.9| 114.5|
| B         | 0   | 97.8| 97.7| 97.7| 101.5| 93.4|
| C         | 0   | 101.1| 101.1| 102.9| 93.4|
| D         | 0   | 101.7| 51 | 93.5|
| E         | 0   | 93 | 93.5|
| F         | 0   | 99.9|
| G         | 0   |

Based on Table 7, after obtaining the saving matrix, the distribution route based on the highest cost-savings matrix value. The new distribution routes are: A, G, C, F, D, E, B. The next step is to determine the order of taking the goods to each supplier using the farthest insert, nearest insert, and nearest neighbor procedures.
A. Farthest insert

Table 8. Order Code & Total Mileage of Milkrun Truck in Cikarang Area Using With Farther Insert Procedures

| Procedure          | Code Sequence | Supplier Sequence            | Mileage   |
|--------------------|---------------|------------------------------|-----------|
| Farthest Insert    | DN → G → A → F → C → D → E → B → DN | PT. Denso → PT. Sunyama → PT. Triwall → PT. Yamani → PT. Nesinak → PT. CNC → PT. Suryastiti → PT. Yamanou → PT. Denso | 136.8 Km |

B. Nearest Insert

Table 9. Order Code & Total Milkrun Truck Mileage in Area Cikarang Using Nearest Insert Procedure

| Procedures | Code Sequence | Supplier Sequence          | Mileage |
|------------|---------------|----------------------------|---------|
| Nearest Insert | DN → B → F → C → D → E → A → G → DN | PT. Denso → PT. Yamanou → PT. Yamani → PT. Nesinak → PT. CNC → PT. Suryastiti → PT. Triwall → PT. Sunyama → PT. Denso | 138.6 Km |

C. Nearest Neighbour

Table 10. Code Sequence & Total Milkrun Truck Mileage in Cikarang Area Using Nearest neighbors Procedures

| Procedures | Code Sequence | Supplier Sequence          | Mileage |
|------------|---------------|----------------------------|---------|
| Nearest Neighbour | DN → B → F → C → D → E → A → G → DN | PT. Denso → PT. Yamanou → PT. Yamani → PT. Nesinak → PT. CNC → PT. Suryastiti → PT. Triwall → PT. Sunyama → PT. Denso | 139.6 Km |

Based on saving matrix method, it can be seen which procedure produce the shortest distance. Comparison of mileage from 3 above procedure can be seen in table 11.
Table 11. Comparison of Mileage 3 Procedure Saving Matrix

| Procedures     | Code Sequence            | Mileage   |
|----------------|--------------------------|-----------|
| Farthest Insert| DN → G → A → T → C → D → E → B → DN | 136.8 km  |
| Nearest Insert | DN → B → T → F → C → D → E → A → G → DN | 139.6 km  |
| nearest Neighbor| DN → B → T → F → C → D → E → A → G → DN | 139.6 km  |

After determining the picking route from the Cikarang milkrun truck, total mileage can be seen in table 12:

Table 12. the Comparison of Mileage of Initial Routes and New Routes (Saving matrix) Milkrun Truck in Cikarang

| variable | Insert PT Sagirama into Cycle Route 1 | New Route | Difference | % Saving |
|----------|--------------------------------------|-----------|------------|---------|
| k Tempuh| 160.7 km                             | 139.6 km  | 23.9 km    | 15%     |

Based on the Table 12, the total % savings gained by the new route is 15% or equivalent with the mileage reduction as far as 23.9 Km. Based on the calculation it is proposed that new price / trip milkrun Cikarang = Rp. 938,000 - Rp. 30.700 = Rp. 907.300.

5. Conclusion

Based on data processing and data analysis in the previous chapters, it can be drawn some conclusions, namely:

1. Truck loading conditions on the previous cycle 1 were only 7 pallets or 70% of the total truck capacity. Then for cycle 2 was only 5 pallets or 50% of the truckload which is 10 pallets. Since October 2016, merging cycles 1 and cycle 2 can be done, so it becomes only 1 cycle pick up / day. Total savings in terms of transportation cost after deducting the needs of outer box every month is Rp. 210,000,000 / year.

2. The Cikarang milkrun route is determined using 3 procedures of saving matrix method, such as the nearest insert, farthest insert and nearest neighbor. The nearest insert and nearest neighbor procedure resulted in the same pickup distance of 139.6 km. Whereas with the farthest insert procedure, the mileage of taking the goods is 136.8 km, then there is a saving mileage equal to 15% and propose the reduction of transportation cost per trip is Rp. 30,700, so the new milkrun price of Cikarang area / trip becomes Rp. 907300.

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