

Delivery System Design of the Local Part to Reduce the Logistic Costs in an Automotive Industry

Inaki Maulida Hakim, Alesandro Romero

Abstract—This research was conducted in an automotive company in Indonesia to overcome the problem of high logistics cost. The problem causes high of additional truck delivery. From the breakdown of the problem, chosen one route, which has the highest gap value, namely for RE-04. Research methodology will be started from calculating the ideal condition, making simulation, calculating the ideal logistic cost, and proposing an improvement. From the calculation of the ideal condition, box arrangement was done on the truck has efficiency with three trucks delivery per day. Route simulation making uses Tecnomatix Plant Simulation software as a visualization for the company about how the system is occurred on route RE-04 in ideal condition. The last step is proposing improvements on the area of route RE-04. The route arrangement is done by Saving Method and sequence of each supplier with the Nearest Neighbor. The results of the proposed improvements are three new route groups, where was expected to decrease logistics cost and increase the average of the truck efficiency per day.

Keywords—Logistic cost, milkrun, simulation, efficiency.

I. INTRODUCTION

MORE infrastructure development with increasing economies of Indonesia, resulting in the rivalry between the manufacturing industry that is increasingly tight. Based on percentage data [1], Indonesia's economic growth recorded positive results, with the economic data is increasing from year to year, namely amounting to 4.5% in 2011, 6.1% in 2012, 6.5% in 2013, and 6.3% in 2014. This is also evidenced by the acquisition of data [2] that the growth of large and medium manufacturing industry in 2011 amounting to 4, 10%, while in the year 2012 be 3.96%, and then continued into a 6.1% in 2013 and 6.5% in 2014. The economics of globalization led to the development of fast growing, either from a network of air, sea, or land in the distribution of goods. The manufacturing industry is also required to be able to see the occurred changes in the internal and external environment of their company.

This research will become a case study in an automotive manufacturing company, where the company is one of the companies based in Indonesia that supply the automotive components from many suppliers, with sales of both domestic and overseas.

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As in [3], simple logistics can be defined as the provision of an item is needed, where procurement can be carried out directly by the parties that require or undertaken by the other party. So it can be said that logistics play an important role in determining the competitiveness of an organization. Competitiveness can be seen from two dimensions, namely the primacy of value and cost advantages. The fee is meant here is the cost to control the efficiency of the flow and storage of goods from point of origin towards the end point. Therefore, it takes a good design from the company's logistics system in order to reduce the cost of logistics. In this company, there is the problem of the high cost of logistics, which is at Plant A and Plant B there is a difference between the costs of planning and actual cost, in November 2014 until January 2015. It brings the number of differences between the delivery trucks as a planning and actual data, which occurred from November 2014 until January 2015.



Fig. 1 Logistic Cost (Plant A)

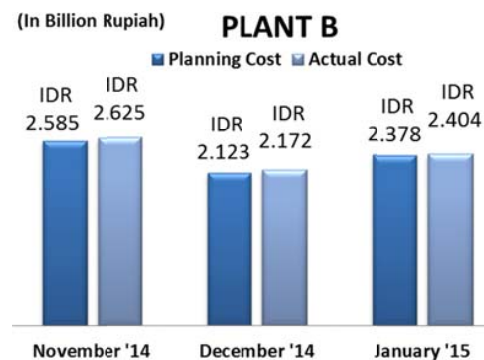


Fig. 2 Logistic Cost (Plant B)

Then the data obtained as a difference between planning with actual data, from November 2014 until January 2015.

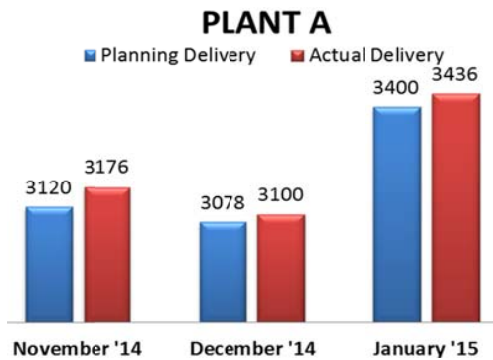


Fig. 3 Number of Truck Delivery (Plant A)

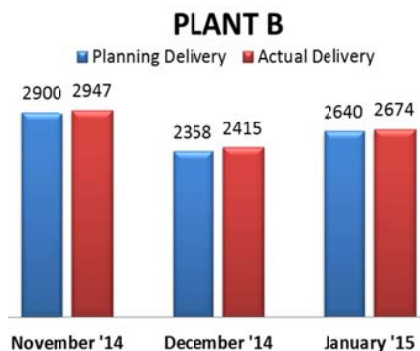


Fig. 4 Number of Truck Delivery (Plant B)

The numbers of delivery trucks were obtained from many routes, so the researchers describe that problems to be differences between the numbers of delivery trucks as the target of planning company with what occurred from November 2014 until January 2015 from each existing route. Obtained data from both plants that the route there were differences also in 3 months had. Gap distinction that got the biggest difference is route dk35 and ik02 on plant A, as well as on routes re04 plant B.

Differences caused by additional delivery caused two things namely overflow and special conditions. Overflow caused by reports from companies that truck is need more truck delivery because the capacity of being less. While special condition is a condition that causes additional delivery caused by an accident of that truck forklifts, accident and other similar incident.

A difference (gap) occurring in RE-04 route caused by excess capacity (overflow) on three months had. While on a route DK-35 and IK-02 and, that use of direct delivery system, it's not there were reports that there are exceeding load capacity, and only found A report that do delivery pallet empty related from the company.

From the data three months that has been obtained, it would be limited to in January 2015 because the gap which most magnitude happens only in that month. So, we can conclude that the main problem happened on a route RE-04 in January 2015, which will be brought in this research. The purpose was to get logistics design of the delivery local part to reduce costs logistics company, with the results of research will be used as a study and of the proposed fixes on the problem to the

process of logistics local components.

II. METHODOLOGY

A. Milkrun Logistics System

Milkrun logistic delivery system is a method that uses a route for the procurement of goods from the supplier or to consolidate. "Milkrun", referring to [4], [5], is the story of a seller of dairy cattle around the village of bringing fresh milk in bottles to be sent in door to door to every house being of their customers. Every time the seller milk arrived in the face of the house of their customers, he will take that there are empty milk bottles in front of a door that has been prepared earlier and replace it with a bottle of milk containing milk fresh from his farm. This routine performed by the seller of milk from day to day with relatively the same time every day.

It is going to happen the process of exchange between which the content and empty. The core of milkrun system is joining two shipping or more than two suppliers or more in one pickup in a route. In milkrun, a vehicle operated at a particular time for visiting several suppliers and shipped it to plant.

B. Clarke-Wright Saving Method

Method of Clarke-Wright Savings Method is a procedure exchange, where a collection of route in any area of exchanged for a bunch of route get better. This method, as in [6], is one of the methods a heuristic used to resolve VRP, that can also maximize many constrain because it can be used to determine the route and the order a visit on a route at the same time. Steps on this method are as follows:

- Make the distance matrix is a matrix with the distance between the plant and the supplier point distance between suppliers.
- Make the distance between the plant matrix savings with suppliers and several other suppliers in the area.
- The highest value of saving the beginning of the route to be created.

At a later stage, iterative process that will be started from the largest matrix to a matrix that is worth little, until each matrix was evaluated for saving further service improvements.

C. Simulation

As in [7], simulation is a replication or visualization of the behavior of a system, for example, a plan that runs on a specific time period. So it can be said that it is a replication or visualization the process of the implementation of the model into software, and executes the software to imitate or resemble a real system for the purpose of studying the behavior of a particular system, training, or other involving a real system.

III. RESULTS

Data processing will be divided into several stages, namely the achievement of the ideal conditions, simulating the manufacture of ideal conditions, calculating the ideal logistics costs, and ending with the manufacture and analysis of the proposed improvements.

A. Calculation of Ideal Conditions

Steps to resolve the first problem to be addressed in this research is to create ideal conditions that will be used as a handle by the company. With the same volume problem but with a different number of delivery trucks, pallet packing arrangement in the truck is one of the best ways so it can be determined that the number of trucks needed by the rest of the space is minimum.

Data processing ideal for structuring box on the capacity of the truck consists of several steps the calculation as follows:

- Make a list of all the parts that are sent through the route in question (RE-04) with the data part number, supplier, and the number of parts delivered.
- Make a list of the type and number of the box that is used each supplier.
- Calculate the total number of boxes that can be loaded in a truck with a volume obtained from multiplying the length, width, and height of the box with his number.
- Simulation box into the truck using the software to get the real condition of the total number of such calculations.

B. Calculation of Ideal Conditions

This simulation was made using the Tecnomatix Plant Simulation, visualization for companies on how the system is going on the route RE-04 in ideal conditions. Simulation model used in the manufacture of objects as follows:

1. Source

Source is an object, which can result in an entity when entering the system. The author uses 6 pieces each source producing a different entity types based on its suppliers, and 1 piece of source to produce trucks (in the program, it is known transporter) used to take charge of Karawang Plant headed to several suppliers.

TABLE I SOURCE NAME AND ENTITY	
Source Name	Entity
Source	Transporter
Source1	Part1
Source2	Part2
Source3	Part3
Source4	Part4
Source5	Part5
Source6	Part6

2. Entity

Entity is an object to be processed in the simulation model. The author uses 6 pieces each entity as a kind of part that is delivered by each supplier.

3. SingleProc

SingleProc is an object that serves to process entity. In this model, which is used SingleProc of 7 pieces for each model the supplier and Karawang Plant is in this route.

4. PlaceBuffer

PlaceBuffer is an object that serves to store temporarily entity in accordance with the specified capacity. This

simulation model using a single unit placebuffer, called "SingleProc7". This object is simulated as a temporary warehouse at Karawang Plant that has unlimited capacity.

TABLE II
NAME OF ENTITY AND PROCESS

Entity Name	Process
Part1	SingleProc1-TransferStation
Part2	SingleProc2-TransferStation1
Part3	SingleProc3-TransferStation2
Part4	SingleProc4-TransferStation3
Part5	SingleProc5-TransferStation4
Part6	SingleProc6-TransferStation5

TABLE III
SINGLEPROC NAME AND SUPPLIER

SingleProc Name	Supplier
SingleProc1	TRI
SingleProc2	KYB
SingleProc3	SGS
SingleProc4	ASMO
SingleProc5	NHC
SingleProc6	SC
SingleProc7	Plant Karawang

5. Transporter

Transporter is an active object entity that can load and bring it to the destination object. In this model, the transporter is used to model the truck route. Transporter will move from Karawang Plant, leading to 1 which named TRI supplier, then headed to the supplier 2 that KYB, and continues to move in the sequence numbers of the suppliers above, which would end up returning to the Karawang Plant. Transporter will be a limited number of its units in one delivery system.

6. Track

Track is a passive object that serves as a transporter path. Track exist in this simulation using several pieces that set in accordance mapping the region, thus forming a closed-loop of Karawang Plant headed to some suppliers and back toward the Karawang Plant. In this model, the track can only be traversed in one direction so that the transporter cannot walk backwards toward his arrival.

7. Transfer Station

Transfer Station is an object that serves for the process of loading and unloading cargo from an object into the transporter or vice versa. In this simulation, there are 6 units Transfer Station to load the goods to the transporter in each supplier, and one TransferStation to unload from the transporter at Karawang Plant. Every process of loading the goods on each supplier varies according to the data obtained from the company.

8. Drain

Drain is an object that serves as the expiration of the entity after undergoing the whole process on the system. In this model, drain described as a part of its stored at Karawang Plant, which had been taken from each supplier.

TABLE IV
NAME OF SUPPLIER AND TIME LOADING

Supplier	Loading Time (min.)
TRI	15
KYB	15
SGS	15
DI	20
NHC	15
SC	20

9. EventController

EventController is an object that is used to control an existing simulation. It is including start, stop, accelerate, and slow down the simulation.

C. Calculation of Ideal Conditions

The third step of the solution to this problem is to calculate logistics costs in ideal conditions. The author makes a simple mathematical formula to calculate logistics costs as follows:

$$T_{LC} = \sum_1^n [x_n \times B_n] \quad (1)$$

whereas

$$x_n = ((V_p \times V_{BOM}) \div Cb) \div Ct \quad (2)$$

T_{LC} , Logistic Cost; x_n , Delivery Truck; B_n , Price of Delivery Truck; V_p , Volume Production; V_{BOM} , Volume BOM (*Bill Of Material*); Cb , Capacity Box; Ct , Fill Capacity Trucks.

D. Design of Proposed Improvements

The design is likely to be applied to the company are contained in these groupings these regions RE-04. The preparation of these groupings does with saving method. Daily production volume of each supplier will be input in the process of determining the route, as well as the total volume in one route will be used to calculate the amount of the delivery and efficiency of the truck.

Due to this study based on these issues RE-04, which is at the area Cibitung, the preparation of this route will be limited to an area Cibitung.

Overall these phases consist of two steps of determining the number of suppliers in one route and determine the order of his visit. Steps of determining the number of suppliers with Saving Method while his visit to the Nearest Neighbor sequence.

In the completion of this study, these two steps will be combined in Fig. 6 as a diagram showing the overall steps of determining a route that includes Saving Method and Nearest Neighbor.

The first step is to use the data matrix mileage of each supplier to the matrix is then used in calculating the savings if the merger is done. Distance can be calculated savings obtained if the two suppliers combined into one route. The following formula is used and examples of manual calculation distance savings for the supplier ASMO and ATL:

$$S = d(0, A) + d(0, B) - d(A, B)$$

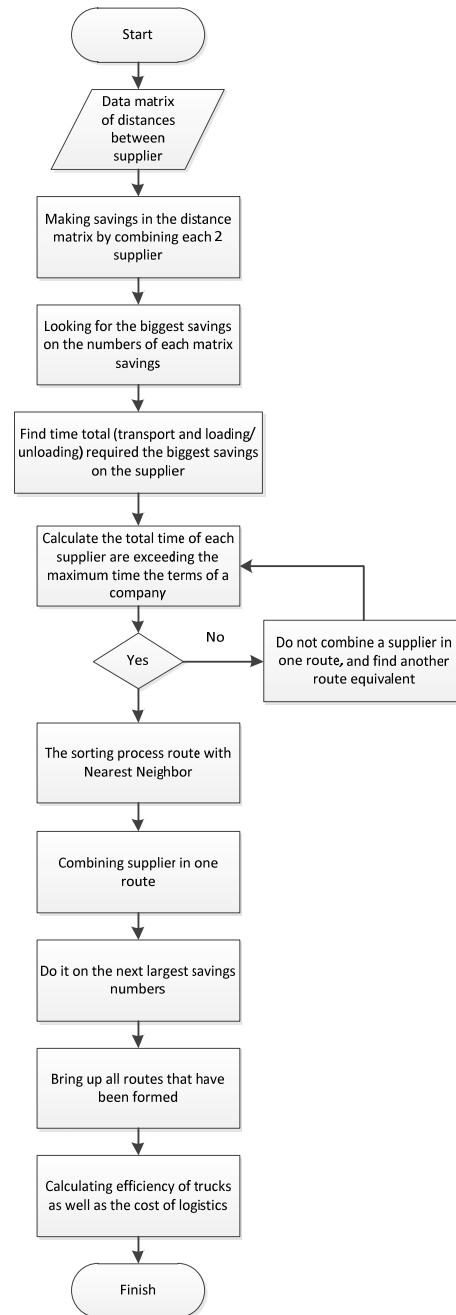


Fig. 6 Route Determination Steps

$$S = d(PLANT, ASMO) + d(PLANT, ATL) + d(ASMO, ATL)$$

$$S = 36.2 + 48.2 - 5 = 79.4 \quad (3)$$

S, Savings distance; $D_{i,j}$, The distance from point i to point j or j to i.

From (3), it was obtained savings within a distance of 79.4 km by combining supplier ASMO and ATL in one route. For all tables supplier will then be calculated as above.

From the matrix of the savings, the values of the biggest savings have been taken to be combined. On saving matrix

samples were taken between supplier ATL value 94.4 and SGT as an example calculation. Referring to the parameters used are travel time and the volume of shipments, the incorporation of ATL and SGT conducted tests on two conditions.

If the supplier ATL and SGT combined into one route, the number of dock that will be visited by as many as 1 dock. Sequencing the supplier uses the Nearest Neighbor method, that visit the supplier which has the farthest distance location from Karawang plant. When seen at a distance matrix, ATL distance to the plant is farther than the SGT, that the visit starts from ATL, and then SGT. Travel time required between suppliers can be seen in the matrix of time. So the calculation of distance and time will be as follows:

$$\text{ATL - SGT - Industry} = 20 + 62 = 82 \text{ minutes}$$

$$\text{ATL - SGT - Industry} = 1 + 47.2 = 48.2 \text{ km}$$

Total time in the route calculated by the sum of travel time, travel time between the dock, and when loading or unloading. The average time of travel between the docks that used in this study was 5 minutes, while the average time unloading is 40 minutes, so the total time of the route calculation are:

✚ Loading and unloading time = 40 minutes / stop point

✚ Travel time between the dock = 5 minutes

✚ Total time of loading and unloading = Total points dismissal x 40 = 3 x 40 = 120 minutes

✚ Total traveling time between the dock = (Number dock-1) x 5 = (1-1) x 5 = 0 minutes

✚ Total time = Total time of loading and unloading + travel time between the dock + travel time = 120 + 0 + 82 = 202 minutes

With conditions as above, the total time of one route for ATL and SGT is equal to 202 minutes. That time in accordance with the requirements of the company that less or equal to 10 hours (600 minutes).

From the test results the condition of total travel time, the incorporation of ATL and SGT already qualified so that ATL and SGT combined into one route. The whole of this step is iteration, so the next step as the steps described above until all suppliers have a route.

IV. DISCUSSION

A. The Ideal Condition

The results of these calculations produce an average efficiency of 97.4% with the use of trucks as much as three units per day.

The calculation results have also been demonstrated with the simulation that has been done using Autodesk Inventor (Fig. 7) for the arrangement to visualize the box into a truck that can be used in the calculation of actual conditions (as in [8]).

From these calculations, simulations run with the Tecnomatix Plant Simulation to provide visualization of the company regarding logistics system that occurs when run under ideal conditions. From the simulation, obtained the

number of pallets to be taken every day in the amount of 82 pieces, and each month is 1679 pieces, if the use of trucks as much as three trucks per day such as visualization and calculations above.

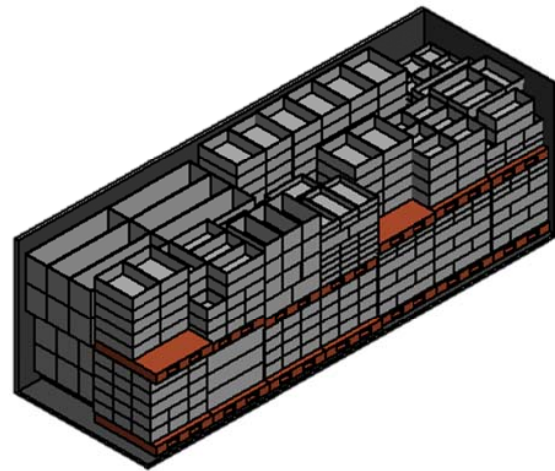


Fig. 7 Simulation Setup Box against Trucks

TABLE V
CALCULATION RESULTS SIMULATION

Variable	Number
Total Throughput _{day}	82
Total Throughput _{month}	1679

Calculation of logistics costs when in ideal conditions, where the cost of logistics for that route only Rp. 117.804.000,- in a month with only 60 delivery trucks. It's very different when we compared to the actual conditions that occur, where there is 87 month delivery truck resulting in a cost of Rp. 170.815.800,-.

By that calculation, we can recommend to the companies that can reduce costs Rp. 53.011.800,- in a month when making arrangement of the box implemented in this company.

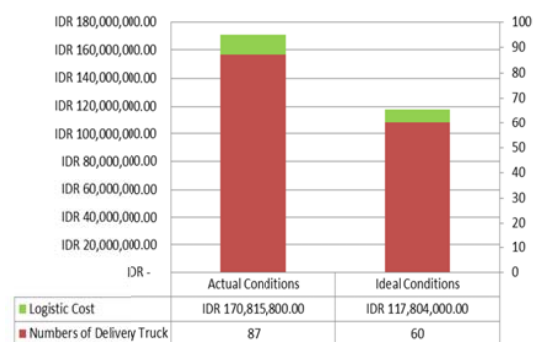


Fig. 8 Differences Actual Condition with Ideal

B. Proposed Improvements Conditions

After getting the results of the new grouping, counting the cost of shipping is done at the basic cost approach. Financing which used by the company is the cost per delivery, where

each route has different shipping cost. The use of ratio cost per kilometer distance because the distance is a variable component of transportation costs. The following is the calculation of the price that the region Cibitung which uses the same Third Party Logistics (3PL).

The approach is using the basic price between the company and third party logistics (3PL). Then the average price per kilometer distance Rp 17,846, - is used as the ratio for calculating the logistics costs of the data proposed improvements.

From these calculations, it can be produced cost of logistics in n delivery trucks. The new route calculation, obtained cost only Rp 23.844.040,60 in a day. It's very different when compared to the actual conditions that occur wear the old route which produces a day fee of Rp 27.810.600,00.

TABLE VI
CALCULATION OF COST PER KILOMETER

Route Before	Price of Truck	Distance	Cost/km
RE03	IDR 927,000.00	50.7	IDR 18,284.02
RE04	IDR 1,963,400.00	84.1	IDR 23,346.02
RE13	IDR 927,000.00	43.5	IDR 21,310.34
RE22	IDR 787,600.00	65.6	IDR 12,006.10
RE23	IDR 927,000.00	64.9	IDR 14,283.51
Average			IDR 17,846.00

TABLE VII
CALCULATION OF COST DELIVERY

Route Before	Number of Trucks Delivery	Price of Truck	Cost
RE03	3	IDR 927,000.00	IDR 2,781,000.00
RE04	3	IDR 1,963,400.00	IDR 5,890,200.00
RE13	7	IDR 927,000.00	IDR 6,489,000.00
RE22	9	IDR 787,600.00	IDR 7,088,400.00
RE23	6	IDR 927,000.00	IDR 5,562,000.00
Total			IDR 27,810,600.00

In addition to the cost parameters, there are parameters that can be improved truck efficiency when using the new route of the proposed improvements. Truck efficiency obtained from:

$$Eff. = \frac{\left(\frac{V_{shipping}}{V_{truck}}\right)}{n} \quad (4)$$

$Eff.$: Truck Efficiency, $V_{shipping}$: Total Supplier Volume, V_{truck} : Truck Capacity Volume, n : Truck Delivery.

So the second parameter calculation, we can recommend that company can reduce costs Rp. 3,966,559.40, - in a day, and increase the efficiency of trucks by an average of 8.78% per day when making his new grouping which has explained above when the company implementing its planning data in the region Cibitung.

V. CONCLUSIONS

One of the issues facing automotive companies in this case study is the high cost of logistics company in allowing tendencies caused its logistic operation running in the absence of good planning. It is causing additional truck delivery could not be predicted from the outset by the company when there

are problems that occur. So, logistics design is required to reduce the cost of logistics companies.

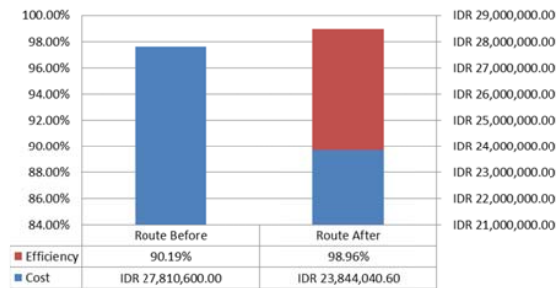


Fig. 9 Comparison between Old Route and New Route

The design of the ideal conditions yielded an average of 97.4% efficiency with the use of trucks as much as three units per day. These calculations proved using the simulation on Autodesk Inventor to visualize the actual condition of the Setup box in the truck. This design continued with manufacture simulation using Tecnomatix Plant Simulation, as visualization to the company about how the system that occurs on the route RE-04 in the ideal conditions.

The results of the simulation showed that the total uptake pallets per day as many as 83, and reached one-month fruit in 1679 with the use of the delivery truck a number of 3 units in one day. With the calculation of ideal conditions, the authors make a proposal to the company that can reduce the cost of Rp. 53.011.800,- in a month when the setup made the box becomes the handle of the company in implementing the planning data.

After getting ideal conditions, the author makes the draft proposal of the improvement in the form of grouping of suppliers using Saving Method generates three basic routes are:

Route 1 : ATL, GSEI, TTEC, SII, and TRI

Route 2 : SGT, SEIWA, TBINA, ICH, and KYB

Route 3 : SGS, NHC, ASMO, DENSO, DSI, and NTC

With the implementation of the proposals of this improvement, companies can lower the Rp 3.966.559 .40 in one day and raise the efficiency of the truck average of 8.78% per day. The proposed suggestion on solving the next issue includes:

1. Issues taken at this research based solely on one route. It would be better if the next study examining other routes that lead to the high cost of logistics companies.
2. In the calculation of costs for new routes in the proposed improvements to the research use approach price per km. It will further enhance the accuracy of the calculation of costs when using the details of transportation costs.

REFERENCES

- [1] Bank Indonesia, Kementerian Keuangan dan Lembaga Internasional. (2014). Laporan Perekonomian Indonesia 2011-2014.

- [2] Badan Pusat Statistik Indonesia. (2014). Berita Resmi Statistik No. 45/05/Th.XVIII.
- [3] Blueprint of Penataan dan Pengembangan Sektor Logistik Indonesia. (2008). Lampiran Peraturan Presiden Republik Indonesia Nomor 26 Tahun 2012.
- [4] Gyulai, D., Pfeiffer, A., Sobottka, T., & Váncza, J. (2013). Milkrun Vehicle Routing Approach for Shop-floor Logistics. Forty Sixth CIRP Conference on Manufacturing Systems 2013, 127-132.
- [5] Lowe, D. (2002). The dictionary of transport and logistics. Kogan Page.
- [6] A. Min'e, D. Simson, & D. Talia. (2013). A Heuristic Approach Based on Clarke-Wright Algorithm for Open Vehicle Routing Problem. Hindawi Publishing Corporation.
- [7] Law, A., W. Kelton. (2000). Simulation Modeling and Analysis 3rd. McGraw-Hill
- [8] George, J. A., & Robinson, D. F. (1980). A heuristic for packing boxes into a container. Computers & Operations Research, 73, 147-156.