

## LEAN AND GREEN APPROACH IN DEVISING OPTIMIZATION PROGRAM TO DETERMINE DISTRIBUTION ROUTES BY USING TABU SEARCH METHOD

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### ABSTRACT

*In the logistics distribution system, the determination of a vehicle route is an important factor. There are several approaches that can be taken to determine the best route vehicles, depending on the objectives to be achieved. The "Lean" in the distribution system chooses a vehicle with the smallest capacity in advance so that the more movement but the gap between the consumer and the travel time to the company is minimize. The "Green", preferring to vehicles with the greatest capacity to reduce movement while reducing vehicle emissions. This research aim to compare the approach of "Lean" and "Green" in the determination of these vehicles, the objective function is the total distance traveled and the amount of emissions released and transportation costs. Both approaches are tested using a computer program designed by Tabu Search method in the determination of the optimal value, which is the best vehicle. The outcomes are distance, emissions, optimal routes, the number (amount) of deliveries, and total cost. The results provide the difference between lean and green principles, and the most optimal result from both of the principles in terms of distance, emissions, and cost. And the appropriateness between lean and green principles with theories from supporting journals.*

**Keywords:** *Tabu Search, lean and green, optimal routes, distribution.*

### 1. INTRODUCTION

Transportation is one of the largest emitters and contribute to environmental pollution. Transportation becomes an important aspect for companies that engaged in distribution field such as PT. Primamakmur Langgeng Perkasa, which is a company that engaged in trading and distribution nationwide scale. There are 4 types of vehicles that owned by PT Primamakmur Langgeng Perkasa Tangerang branch and there are 8 amount of cars. The 4 types of vehicles that owned by PT Primamakmur Langgeng Perkasa are 2 Mitsubishi L-300, 5 Counter single Angle and 1 Counter Double Angle, also motorcycle. In fact, to determine the distribution routes, this company only based on intuition and experiences from head of warehouse. To improve the effectivity and efficiency from PT Primamakmur Langgeng Perkasa, lean and green principles are compatible to be applied in this company. To design the optimal routes using lean and green principles, we can use tabu search method.

Tabu search is a metaheuristic method that often use to determine the optimal distribution routes.

The problem that PT Primamakmur Langgeng Perkasa face nowadays is how to optimizing distribution routes besides using intuition head of warehouse and the drivers? Based on the problem above, there are a few purposes from this research that conducted in PT Primamakmur Langgeng Perkasa, there are designing program to determine optimal routes and the proposal of distribution routes using tabu search method seen from emissions, distance, and cost.

### 2. METHODOLOGY

This research start from preparation of research and performed field study, problem identification, problem background, formulating and limiting the problem, research purposes, and literature review. After that here are preliminary study such as field study and literature review. The next step is collecting and data processing. But before that, we calculate to determine what

products that will become our object research using ABC classification. And below is a collecting and processing data flowchart that we do.

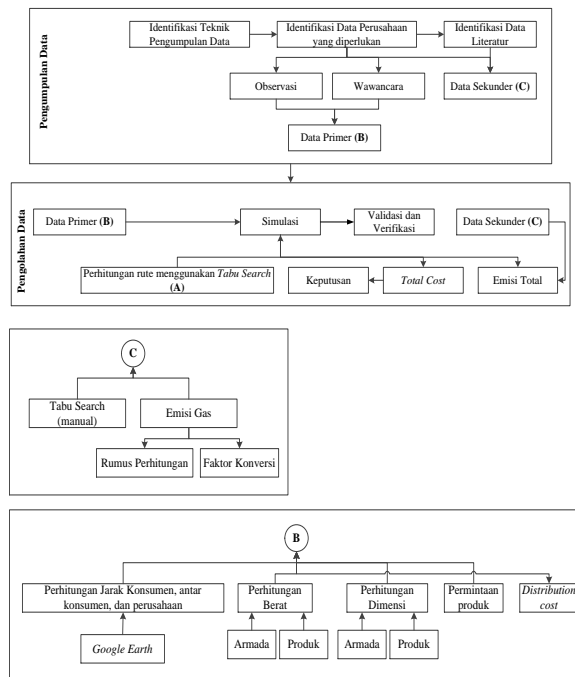


Figure 1. Collecting and DataProcessing

From data collecting, we obtained organization sturcture, transportation vehicle, product, demand, distribution costs, adn results from calculating distance and time matrix.

In the tabu search method, the first thing that is done is product selection as well as checking the daily demand of the number of demand that have been input After meeting the existing criteria , then checking the weight, dimensions and availability of the vehicle to be used. If these criteria are met , then the process will proceed to the next stage, but if it does not, it will be returned to the previous stage of the product selection.

In the next stage, the first process that we do is making the first initial solution which is done by randomization and will be directly inserted into the tabu list. Furthermore, there are moves to get a new route. To get these new neighbors can be done using 1 interchange mechanism. After getting neighbors in one iteration, it will matched if the best route in the iteration, has a better outcome than the last route on the tabu list and whether the route has not been entered into the tabu list. If we have a better results

and have not been entered into the tabu list, it will be inserted into the tabu list and towards the next iteration to meet the stopping criteria. .

In lean methods we can distinguished based on the vehicle capacity and always starts with the smallest capacity, and there are restrictions on prospective neighbors, which require less than the last tabu list (distance). As for the green has a normal tabu search process and using vehicle with the largest capacity . While the combined method, the vehicle can be selected by user and using the normal method of tabu search.

After using the methods of lean and green, the distance and emission results of the two methods used to be the lower and upper limits on the combined method. After getting the results of the combined method, it will be checked if the reslut is between the existing limits. If not then the user is faced with several options that would result in different decisions. To know the complete process, can be seen in Figure 3 .

After collecting and processing the data , we then performed an analysis of the data processing and make some conclusion.

### 3. RESULT

This research starts from the formation of the basic forms of programs to the report form and database . There are several forms with different functions and with different users. There are two types of users who can use this program, the admin and user . In the lean process, the vehicle always starts with the smallest capacity and for the selection of each iteration neighbor, we added restrictions which must be smaller than the tabu list. This makes smaller scope in the choice of neighbors and optimal mileage

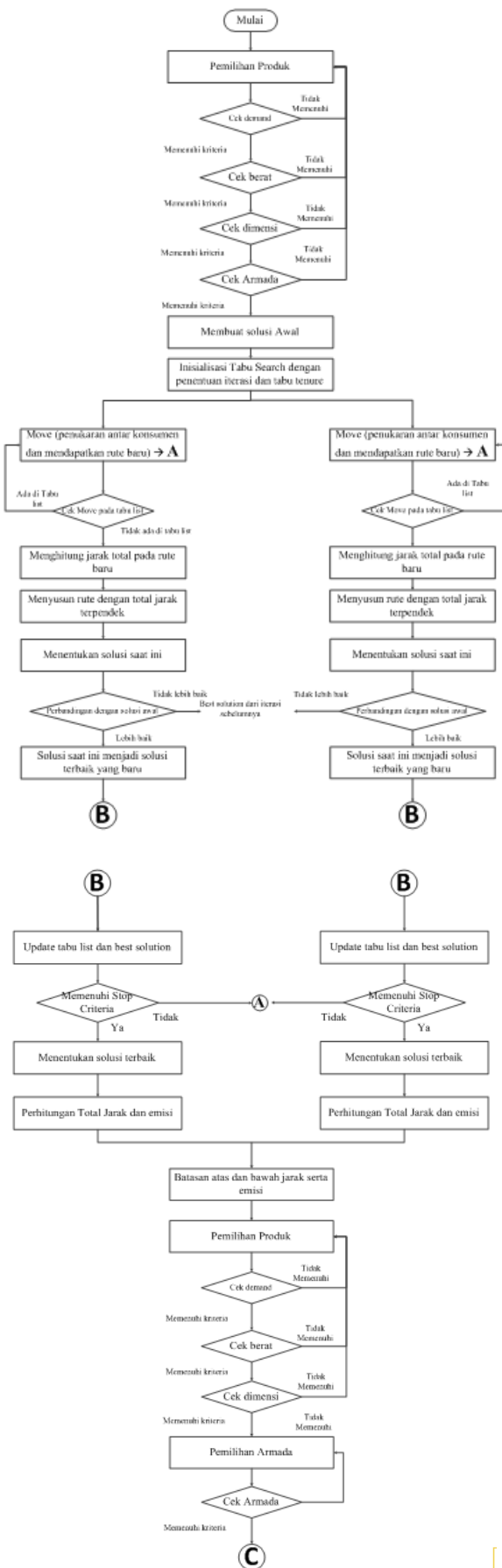


Figure 2. Flowchart Tabu Search

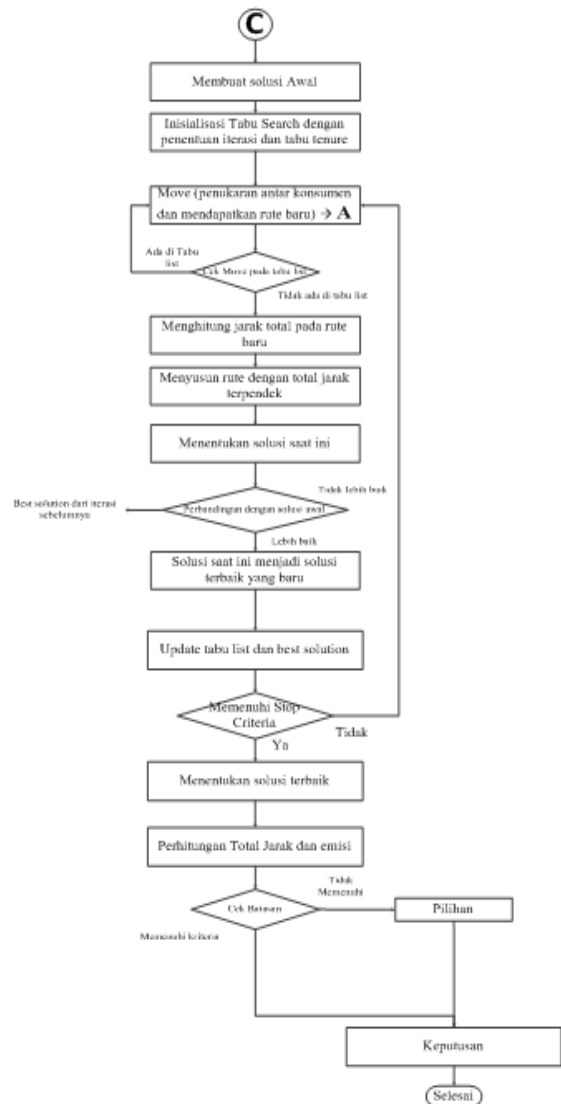


Figure 2. Flowchart Tabu Search(Continuation)

In green method, the vehicle is limited to the vehicle with the largest capacity and the calculation of tabu search under normal circumstances. In the result of the lean and green, we obtained the distance and emission that will be the upper and lower limits on the combined method which will generate an optimal route. This combined method is a method that combines lean and green which use the tabu search method in a simple form. If the distance and total emissions exceed the limits, it produces a few options to reach a conclusion. For each data processing, we obtained up to get a form like Figure 3, Figure 4 and Figure 5.

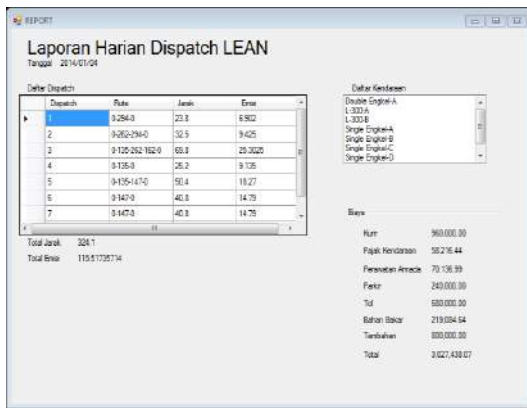


Figure3. Lean Daily Report

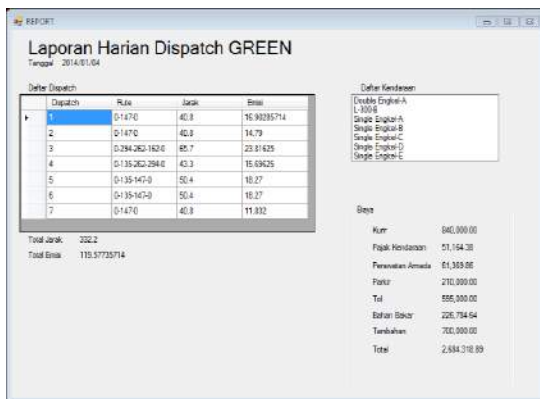


Figure 4. Green Daily Report



Figure 5. Combined Daily Report

In this research, the program first tested to see if verified and valid before continue to the next stage of the calculation. The results of these tests are valid and that the program has been verified and fit for use. However, there are some shortcomings in the implementation of the program, one of them is in the process of program operation that takes a long time.

## 4. RESULT AND DISCUSSION

### 4.1 Calculation of matrix distance and time

Time and distance matrix is a matrix that shows the relationship between distance and time with the company's consumers. The calculation is done using Google Earth. The distance and time that are entered into the data processing are the shortest distance and time by using a four-wheeled vehicles. The reasons for using Google Earth in this calculation of the time and distance is Google Earth provide some alternative to heading to the consumer.

### 4.2 Program Designing

Program to determining the optimal routes in this research were prepared by using visual basic.net which is a tool to develop and build on top of the system . Net Framework using the BASIC language .

Based on the similarities and differences of Visual Basic 6 and . Net , it appears that visual basic.Net is the development of visual basic 6. Not only that , Visual Basic is also suitable for performing calculations and easy to learn .

There are some drawbacks when the program is executed, such as can not perform the calculation if the vehicle just past a single point. Therefore, researcher make additions to existing points with the " DUMMY " point where the presence of the dummy point is expected that the calculating process of 1 point that previously could not be done, will be able to be done because it has been through 2 points now.

The program is a semi-manual. As for some of the reasons why this program can be said to be semi- manually are the program is still using the admin for the care of the database , but it is also in entering data into the program , the user is entering data one by one for the entire demand in one day. Not only that, researchers also counted manually the setting of dispatch per vehicle, before entered into the program .

### 4.3 Validation and Verification

Verifying the program conducted to ascertain whether there are an errors in the coding or not, the formula used to calculate whether the logic is correct and that appropriate or not. To ensure that a program

is already running without an error, then we can running the program. If there is an error, the error dialog box will appear and told the location of the errors in the program.

Furthermore, the validation is done by comparing the calculation in program with manual calculations. This can be done by checking the total distance that exists in the program and from the database (distance matrix) and the calculation of total emissions result from program to manual calculation using the formula. Not only that, also check the calculation of the total cost as well as the logic of lean, green, and combined method on the program is appropriate or not. The result is that the program is valid and verified.

#### 4.4 Tabu search Calculation

In accordance with the principles of lean that deliveries are made in a smaller batches but with the great amount, vehicles used on lean principles always begins with the smallest capacity to largest . While in the neighbor selection tabu search are added restrictions that must be smaller than in the tabu list in order to get optimal results in terms of distance . While the principles of green , the selection of the are normal and the vehicle use with the largest capacity first to fit the principle that is at the dispatch must in the large batches to reduce vehicle emissions and the dispatch amount. While the combination method, using the usual method of tabu search and the vehicle can be selected by user .

Based on Dues , C.M. , Tan , K.H. , Lim , M. (2011), stated that in differentiating lean with green can be distinguished by several attributes . In the journal also mentioned, lean principles will lead to more frequent deliveries of smaller sizes. As well as the existence of this principle , the cost will be smaller . King and Lenox (2001) , states that to reduce one factor in production, it will increase other factors in the context of lean production. They give an example that the more changeover happen from smaller batch need a frequent cleaning and disposal from unused material. Benjaafar et al . (2010) mentions that in the distribution, lean methods will make more and more movement and increase emission because the movement will increase with the

small capacity of each dispatch . But it is undeniable, that by implementing lean methods will minimize the distance between the consumer and the company .

As for the method of green , different from lean methods . In this method , the number of vehicles and the total costs incurred that is smaller than the lean . However , for distances , emissions , and costs green method is more bigger than lean methods . Based on Dues , C.M. , Tan , K.H. , Lim , M. (2011) , stated that the green principle of transport field will be reducing the number of deliveries to reduce the amount of emissions that come out .

The results obtained are random and erratic. Factors that influence the results of the random nature in this research are the product preparation in the vehicle delivery, the large amount of existing customers, and the vehicles. In this research, the preparation of the shipment more to the fulfillment of the existing capacity of the vehicle beforehand. Also consider whether to add an item in a shipment , it will add more distance or not. But there is a condition that for fulfill the vehicle capacity , added one point for one type of goods becomes inevitable . In addition , the more the number of existing customers and the larger vehicles are used , the possibility of distance covered in greater delivery of goods will also increase . Not only that , the use of the type of vehicle will also affect emissions that are released per day.

Given the circumstances that may affect the results of the lean and green , it can be concluded that lean can be green on certain conditions. The optimum results obtained from the program can be seen in table 1 .

## 5. CONCLUSION

### 5.1 Conclusion

From data processing and analysis, we can conclude the program can be built by using *visual basic*.Net and fit in researcher logic. Besides that, the program is valid and verified so it can use to determine optimal distribution routes.

Table 1. Recapitulation of the Combined Method

Date	Dist	E	D	FC (Rp)	TC (Rp)
5th April	584.34	203.1947	6	404,284.04	2,510,963.10
13th April	267.7	98.325	5	186,479.46	1,942,556.18
15th April	226.6	83.33	6	158,044.46	2,264,940.35
16th April	629.9	225.64	7	427,951.07	2,885,485.32
17th April	447.9	160.91	7	305,189.11	2,762,723.35
18th April	410.9	154.735	5	293,464.29	2,049,541.00
19th April	1236.81	442.8564	9	839,900.00	3,648,253.51
20th April	508.1	182.2215	5	345,592.50	2,101,850.03
22nd April	342.3	126	3	238,973.04	1,293,953.86
25th April	477.6	174.67	6	332,494.64	2,439,209.71
27th April	561.6	200.57	7	386,583.21	2,844,117.46
4th May	370.3	132.89	2	252,045.36	956,387.82
6th May	373.9	132.724	5	251,719.29	2,007,976.82
13th May	144	57.49	2	109,047.32	813,208.97
15th May	340.8	127.27	3	252,970.54	1,307,770.54
18th May	361.31	120.7125	3	253,625.63	1,308,425.63
20th May	416.114	158.54	3	300,506.05	1,355,486.88
24th May	964.348	336.32	5	670,080.32	2,426,157.03
27th May	186.6	68.92	5	130,723.21	1,886,799.93
5th June	282.3	103.36	5	196,035.71	1,952,112.43
13th June	523.19	190.48	4	366,479.73	1,771,918.09
15th June	332.2	119.577	7	226,784.64	2,684,318.89
17th June	336.3	119.773	4	227,155.89	1,632,775.07
18th June	693.35	253.79	5	481,333.48	2,237,591.02
21st June	229.279	86.734	2	164,496.36	868,838.82
22nd June	169.468	60.88	3	120,516.39	1,175,316.39
24th June	123.77	51.27	1	97,247.86	450,771.14

**5.2 Recommendation**

There are a few recommendation that can be use for company and the future research:

1. For estimating total emissions and distances, the company shouldn't use intuition. Especially if there are a new consumer that company dont know exactly where it is and can ruin all the optimal routes.
2. For the future research, we hope that the program will be more computerize compare to this program. Because, in this research still semi manual and consume a lot of time to find an optimal routes.
3. To calculate emmissions, we should add factors besides distances to more like reality. Because not just distance that affects the calculation of total emissions, but there are more factors such as the

use of coolers, vehicle operating time, and others.

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