Optimization of Vehicle Routing Using Genetic Algorithm in Package Delivery Distribution: (Case Study at PT XYZ Samarinda Region)

Def Afuww Wildan E[1], Rachmawati W[2]

[1]Master of Logistics Student, Faculty of Industrial Technology, Bandung Institute of Technology
Jl Ganesha No. 10 Bandung City 40132 (Tel. (022) 2504551 Fax. (022) 2509406; e-mail: 29422004@mahasiswa.itb.ac.id)

[2]Permanent Lecturer in Industrial Engineering Study Program, Faculty of Industrial Technology, Bandung Institute of Technology
JL Ganesha No. 10 Bandung City 40132 (Tel. (022) 2504551 Fax. (022) 2509406; e-mail: rwangsap@itb.ac.id)

(Received: Nopember 2024, Revised: Februari 2025, Accepied: April 2025

Abstract— In recent years, companies in Indonesia and around the world have focused on logistics costs to achieve efficiency in the supply chain. This research focuses on vehicle route optimization in the package distribution process at PT XYZ in the Samarinda region, taking into account service time, demand, and vehicle capacity. The problem addressed is the delay in land transportation that causes inefficiency in package distribution, which is solved using a genetic algorithm to generate the minimum travel distance and the shortest route, in order to minimize sustainable package distribution costs. The research results show optimization of the number of fleets and routes, as well as a significant reduction in total travel distance and total distribution costs.

Keyword: Supply Chain, Logistics, Vehicles, Transportation, Optimization, Linear Programming, Genetic Algorithm, Hyrbid, Supply Chain, Shortest Route, Vehicle Routing Problem.

I. Introduction

In recent years, companies in Indonesia and worldwide have been focused on logistics costs to achieve efficiency in the supply chain. This is done to maintain and improve customer satisfaction levels so that companies can keep heir market position. Transportation in community life plays a very important role, as it includes many types of activities, such as economic activities and community activities that can generally run smoothly with the existence of transportation.

In the process of transporting or shipping goods, several factors can affect the shipping cost, namely the type of vehicle, the distance traveled, and the transportation capacity. Freight cost is the expenditure to move goods from the seller's warehouse to the buyer's warehouse. All expenditures for the cost of purchasing transportation will be recorded in the purchasing freight expense account as a transaction record.

PT XYZ is a logistics company that provides services for shipping goods in the product distribution process to customers. Some of the product types served include express, regular, and economy. The problems that arise in the distribution of package shipments include are x-ray failure, External & internal indoor processing, the delay in land transportation, the delay in air transportation, the delay in sea transportation. These problems are summarized in the table below (Table 1). Table 1. The root causes of problems that occurred in East Kalimantan Province based on the Shipping Processing Center in January 2023

Sum of Count	Produk		Grand Total
Root Cause	PJE	PKH	
gagal x-ray		27	27
indoor proses eksternal		55	55
indoor proses internal		4	4
Keterlambatan angkutan darat terjadwal/laut dsb	167	43	215
keterlambatan angkutan udara		122	122
penudaan antaran KPC		8	8
Penundaan antaran		4	4
salah kode		3	3
salah salur ekstemal		28	28
Salah salur internal		2	2
Grand Total	173	264	468

This research discusses the optimization of vehicle routes based on vehicle capacity constraints using a Genetic Algorithm (GA) method to generate the minimum travel distance and the shortest route, in order to minimize the distribution costs of sustainable package deliveries. The research focus is on PT XYZ in the Samarinda region, where there were 44 delayed deliveries to the destination in January 2023, with 20 delayed deliveries from the Samarinda Office and 24 delayed deliveries from the Branch Office.

II. Literature review

A. Logistic

Logistics typically refers to the activities that occur within the boundaries of a single organization, while Supply Chain refers to the network of companies that work together and coordinate their actions to deliver a product to

P-ISSN 1858-2680
E-ISSN 2723-4673

the market. Also, traditional logistics focuses its attention on activities such as procurement, distribution, maintenance, and inventory management. (Hugo M. 2003).

B. Logistic Management

Logistics management is the science and/or art, as well as the process of planning and determining the needs for procurement, storage, distribution, and maintenance, as well as the movement of materials/equipment, so that logistics management is able to answer the objectives and ways to achieve the objectives with the availability of logistics materials whenever needed and used efficiently and effectively (Subagya, 1994).

C. Transportation

Transportation is the physical movement of people or goods from one place to another within a specific time, using or driven by humans, animals, or machines. In general, transportation is divided into three types: land transportation, sea transportation, and air transportation. The Transportation System is a combination of several interconnected components or objects. In any organization, a change in one component will result in a change in another component (Tamin, 2008).

D. Vehicle Routing Problem

According to Rahmi and Murti (2013), the Vehicle Routing Problem (VRP) is a problem in the distribution system that aims to create an optimal route, with a group of vehicles of known capacities, in order to meet customer demands with known locations and quantities. An optimal route is a route that meets various operational constraints, namely having the shortest total distance and travel time in meeting customer demands, while using a limited number of vehicles.

E. Classification of Vehicle Routing Problem Types

According to the text, there are several types of Vehicle Routing Problems (VRP) that depend on the number of constraints and the objectives to be achieved. The most common constraints used are distance and time. The objectives to be achieved are usually minimizing travel distance, time, or cost (Indra et al., 2014). Based on the constraints, Vehicle Routing Problems (VRP) can be classified into several types, including:

a. MTVRP (Multiple Trips Vehicle Routing Problem), each vehicle can serve more than one route to meet the needs of customers.
b. VRPTW (Vehicle Routing Problem with Time Windows), each customer served by the vehicle has a time window for receiving service.
c. Pickup and Delivery Vehicle Routing Problem, there are a number of goods that need to be moved from a specific pickup location to another delivery location.
d. CVRP (Capacitated Vehicle Routing Problem), vehicles have limited carrying capacity (capacity) of goods to be delivered to a location.

F. Linier Programming

According to Mahto, Dalgobind (2012), Linear Programming (LP) is a widely used mathematical technique designed to assist managers in planning and decision-making relative to the allocation of resources. It is a mathematical method for determining how to achieve the best result in a given mathematical model for some list of requirements represented as linear relationships. More formally, linear programming is a fairly large field of optimization for several reasons. Many practical problems in operations research can be stated as linear programming problems. Certain special cases of linear programming, such as network flow problems and multicommodity flow problems, are considered important enough to generate a lot of research on specialized algorithms for their solution.

G. Genetic Algorithm

Genetic algorithm is a search technique in computer science for finding approximate solutions to optimization and search problems. Genetic algorithms are a specific class of evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, natural selection, and recombination (or crossover). Genetic algorithms are optimization and search techniques inspired by the process of natural evolution. The basic idea of genetic algorithms is to create a population of candidate solutions, and then develop it through a process of selection, crossover, and mutation to obtain the optimal solution.

P-ISSN 1858-2680
E-ISSN 2723-4673

III. RESEARCH METHODOLOGY

This stage will discuss the conceptual framework and process stages, as well as the desired final results of this research. Based on the problems described, the process requires a research flow/procedure to ensure a structured research process, starting from identifying problems and objectives, collecting the necessary data, and appropriate data processing, in order to obtain the desired research results. The following is a research flow diagram in Figure 1 below.

A. Research Flow Diagram

Figure 1. Research Flow Diagram

B. Research Flow

The research begins with a literature study and field study. The next stage is data collection, starting from the coordinates of the consumer points, the depot (Samarinda DC), demand, vehicle capacity, travel distances between points, and transportation costs. This is followed by the data processing stage, using the genetic algorithm method for optimization to produce the shortest total travel distance and minimize distribution costs for parcel shipments. The final result can be analyzed, and the mathematical model is as follows:

Indeks	Description
j	Indeks himpunan titik tujuan (KCP/Agen)

Parameters	Description	Unit
Q_k	Kapasitas kendaraan k	Unit/day
F_k	Biaya tetap pemakaian kendaraan k	Rp/day
V_k	Biaya variabel per jam setiap kendaraan k	Rp/hour
D_{ij}	Jarak tempuh dari titik i ke titik j	Km
d_j	Permintaan setiap konsumen j	Unit/day

Decision Variable	Description	Unit
X_{ijk}	1 jika kendaraan k melayani titik j setelah melayani titik i, 0 jika tidak	Unitless

Objective Function:

Minimize $Z = \Sigma\, k\, \Sigma\, j\ (F_k + V_k * D_{ij}) * X_{ijk}$ (1)

Constraints Function:

1. Constraint for each point j can only be visited once by vehicle k.

$\Sigma\, k\, \Sigma\, j\, X_{ijk} = 1, \quad \forall j$ (2)

2. Constraint for vehicle k can only depart from point i and return to point i (depot).

$\Sigma\, i\, X_{ijk} = \Sigma j\, X_{ijk} = 1, \quad \forall k, i = \text{depot}$ (3)

3. Constrain for the capacity of vehicle k must not be exceeded.

$\Sigma j\ dj * X_{ijk} \leq Q, \quad \forall k$ (4)

4. Ensuring that the decision variable Xijk, which represents whether vehicle k serves the route from point i to j, can only take the value 0 (not served) or 1 (served).

$X_{ijk} \in \{0,1\}, \quad \forall i, j, k$ (5)

5. Ensuring that the fixed cost (Fk) and variable cost per unit distance (Vk) for each vehicle k are non-negative values.

$F_k, V_k \geq 0, \quad \forall k$ (6)

And the final stage is drawing conclusions to provide a comprehensive overview of the findings of this research..

IV. DISCUSSION

P-ISSN 1858-2680
E-ISSN 2723-4673

A. Data Collection

1) Coordinates of Depot and Consumer Points, and Demand:

Table 2. Coordinates of Depot and Consumer Points, and Parcel Delivery Demand

ID	Lokasi	Koordinat		Jumlah Kiriman
		X	Y	
0	DC Samarinda	117,146	0,5102381	0
1	KC Samarinda	117,143	0,5023381	501,67
2	KCP Samarinda Temindung	117,154	0,48778	153,32
3	KCP Palaran	117,180	0,5670677	49,60
4	KCP Samarinda Sei Kunjang	117,114	0,526065	33,82
5	KCP Muarajawa	117,234	0,823068999	13,38
6	KCP Samarindaseberang	117,142	0,5092209	19,17
7	KCP Samarindamugirejo	117,199	0,452092199	16,76
8	KCP Anggana	117,274	0,571671099	15,64
9	KCP Loaduri	117,066	0,5920681	56,37
10	KCP Bengkuring	117,156	0,4324348	14,51
11	KCP Sultan Sulaiman	117,168	0,508029899	14,71
12	KCP Sungai Siring	117,265	0,3718029	11,13
13	KCP Samarinda Sei Keledang	117,128	0,4849718	38,33
14	KCP Manunggal Jaya	117,103	0,72138099	11,13
15	KCP Muara Badak	117,433	0,3561106	14,31
16	KCP Sangasanga	117,233	0,658165199	14,11
17	KCP Samboja	117,035	1,0130999	15,64
18	KCP Samarinda Ilir	117,155	0,5049515	12,25
19	Agen Family	117,170	0,5316773	173,61
20	Agen Mutiara	117,147	0,500383999	12,55
21	Agen Agung	117,142	0,4971438	11,27
22	Agen Abadi Jaya	117,132	0,5353175	13,38
23	Agen aidil azhar	117,140	0,462371	13,53
24	Agen Cendana Mitra Perkasa	117,158	0,4906978	12,00
25	Agen Septi Wijaya	117,165	0,4720931	32,69
26	Agen eldi sukses mulia	117,144	0,4362258	12,58

2) The number of vehicles available in the company:

Table 3. Number of Available Vehicles

No	Jenis	Rute Eksisting	Keterangan
1	Grandmax	DC Samarinda - KC Samarinda - KCP Samarinda Ilir - KCP Sultan - KCP Anggana - DC Samarinda	Kendaraan DINAS
2	Grandmax	DC Samarinda - KCP Samarinda Sungai Kunjang - DC Samarinda	Kendaraan DINAS
3	Grandmax	DC Samarinda - KCP Samarinda Temindung - KCP Samarinda Mugirejo - KCP Bengkuriang - KCP Manunggal - DC Samarinda	Kendaraan DINAS
4	Grandmax	DC Samarinda - KCP Samarinda Seberang - KCP Loa Duri - KCP Samarinda Sungai Siring - KCP Sungai Keledang- KCP Muara Badak - DC Samarinda	Kendaraan DINAS
5	Grandmax	DC Samarinda - KCP Palaran - KCP Sanga Sanga - KCP Muara Jawa - KCP Samboja - DC Samarinda	Kendaraan DINAS
6	Grandmax	DC Samarinda - Agen Family - Agen Mutiara - Agen Agung - Agen Abadi Jaya - Agen Aidil - Agen Cendana - Agen Septi - Agen Eldi - DC Samarinda	Kendaraan DINAS

3) Matrix of Distances and Cost Matrix:

Table 4. Distance Matrix Between Points

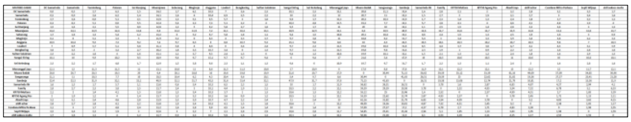
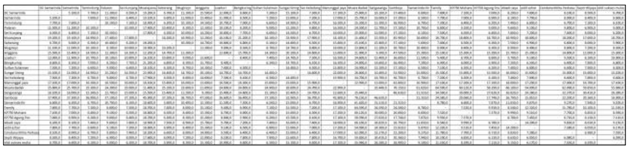


Table 5. Cost Matrix Between Points



B. Data Processing

1) Determining Initial Routes Using Linear Programming:

The steps in determining the optimal delivery routes are as follows:

1. Prepare the initial data, including locations, demand, and X-Y coordinates for 27 locations (1 Depot (DC Samarinda) and 26 Customers (KC, KCP, and Agents)).
2. Collect the data on the vehicles used, which are 6 cars with a capacity of 750 kg each.
3. Calculate the distances between locations using the Euclidean distance formula and construct the transportation cost matrix.
4. Formulate the linear programming model with the objective of minimizing the total transportation distance/cost, and constraints such as each location being visited only once, the total demand not exceeding the vehicle capacity, and each vehicle must return to the depot.
5. Solve the linear programming model using Excel Solver.
6. Obtain 3 optimal routes from the Excel Solver results, then perform further optimization using a genetic algorithm method.

- Route1: 0-8-16-25-13-10-24-3-23-17-21-2-14-0
- Route2: 0-6-18-20-7-15-4-5-9-19-22-11-0
- Route3: 0-12-1-26-0

(The details provided above are based on the information in Table 2).

Based on the information provided, Figure 2 represents a capture of the data processing using the Excel Solver.

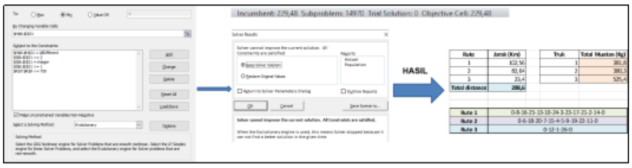


Figure 2. represents the results of the data processing using linear programming with the assistance of the Excel Solver

2) The optimization was performed using a genetic algorithm:

Here is a summary of the steps that were described:

1. The initial step in the genetic algorithm optimization process was to initialize the initial population by generating several initial solutions (chromosomes) randomly, where each chromosome represents a delivery route.

- Route1: 0-8-16-25-13-10-24-3-23-17-21-2-14-0
- Route2: 0-6-18-20-7-15-4-5-9-19-22-11-0

P-ISSN 1858-2680
E-ISSN 2723-4673

- Route3: 0-12-1-26-0

2. Chromosome Fitness Evaluation based on Total Distance or Total Cost, the fitness of each chromosome is evaluated based on the total distance or total cost of the delivery route represented by that chromosome.
3. Parent Chromosome Selection using Roulette Wheel Selection, the parent chromosomes are selected using the roulette wheel selection method, where chromosomes with better fitness values (lower total distance) have a higher probability of being selected.
4. Chromosomal Recombination (Crossover) using Order Crossover (OX), the selected parent chromosomes undergo recombination (crossover) using the Order Crossover (OX) method to generate new offspring chromosomes.
5. Offspring Chromosome Mutation using Swap Mutation, the offspring chromosomes undergo mutation using the swap mutation method to increase the diversity of the solutions.
6. Evaluation and Selection of the New Generation using Elitism, the new generation is evaluated, and the selection process uses the elitism method, where the best chromosomes from the previous generation are retained.
7. Stopping Criteria, the optimization process is stopped based on either a maximum number of generations or the convergence of the solution.

the final solution produced by the genetic algorithm is the best delivery route based on the smallest total distance or total cost.

Table 6. Travel Distances of Routes Based on the LP Method and Genetic Algorithm Method per Day

Alt	Rute Usulan (LP)	Jarak Tempuh (Km)	Totak Jarak/hari (Km)	Penghematan Jarak Tempuh dg Rute Eksisting	Alt	Rute Usulan (GA)	Jarak Tempuh (Km)	Totak Jarak/hari (Km)	Penghematan Jarak Tempuh dg Rute Eksisting
1	Rute 1	102,56	208,6	17,35 %	1	Rute 1	121,71	204,33	19,05 %
	Rute 2	82,64				Rute 2	60,32		
	Rute 3	23,4				Rute 3	22,3		
2	Rute 1	120,3	217,84	13,7 %	2	Rute 1	133,1	237,24	6,01 %
	Rute 2	83,84				Rute 2	85,64		
	Rute 3	13,7				Rute 3	18,5		

Based on Table 6, the route travel distance that results in the shortest total travel distance is using the genetic algorithm method. Therefore, this alternative can be used as the best decision-making option. The selected alternative is alternative 1 (one) using the genetic algorithm method, with a total daily travel distance of 204.33 km. In this case, alternative 1 (one) has provided a 19.05% savings in travel distance compared to the existing route. The existing route has a total travel distance of 252.4 km, while with optimization using the genetic algorithm, the total travel distance can be reduced to 204.33 km.

So, the use of the genetic algorithm method can produce a more efficient delivery route with a shorter total travel distance compared to the existing route. This indicates that alternative 1 (one) using the genetic algorithm method is the best choice for decision-making.

Table 7. Total Costs Based on the LP Method and Genetic Algorithm Method per Day

Rute	Rute Usulan Algoritma Genetika	Jarak (Km)	Jenis Armada	Kapasitas Armada (Kg)	Rasio BBM/ 1 Liter (Km)	Kebutuhan BBM (Liter)	Total Biaya BBM/hari (Rp)	Biaya Sewa Kendaraan/hari (Rp)	Total Biaya Transportasi/hari (Rp)	Total Biaya Transportasi/Bulan (Rp)
1	DC Smr - KCP Bekrg - Agen Aldil - KCP Smr S. Kldng - Agen Agung - KCP Plm - KCP Ang - KCP Sng Sng - KCP Smbl - KCP Mnggal J - KCP Smr Tmndng - Agen Cendana - Agen Pos Septi Wjy - DC Smr	106,69	Grandmax	750	9	24	240.000	100.000	340.000	11.100.000
2	DC Smr - Agen Abadi - KCP Smr S. Knjang - KCP Load - KCP M. Jawa - KCP M. Bdk - KCP Smr Mgrejo - KCP Sltn - Agen Family - Agen Mutiara - KCP Smr Ilr - KCP Smr Sbrang - DC Smr	61,64	Grandmax	750	9	14	140.000	100.000	240.000	7.200.000
3	DC Smr - KCP S. Sring - Agen Eldi Sukses - KC Smr - DC Smr	23,4	Grandmax	750	9	5	50.000	100.000	150.000	4.500.000

The total transportation cost for the existing route per day is Rp. 1,180,000, while the total transportation cost for the optimized route per day is Rp. 760,000. Based on the comparison between the existing cost and the proposed cost, the calculation is extended to a monthly basis. Therefore, the total monthly transportation cost for the existing route is Rp. 35,400,000, while for the optimized route it is Rp. 22,800,000. It can be concluded that this calculation result shows a 34% cost savings per month in the work area of the Samarinda Office (DC Samarinda) after the optimization.

In summary, the optimization of the delivery routes has resulted in a significant 34% reduction in the monthly transportation costs compared to the existing routes in the Samarinda region..

V. CONCLUSION

Based on the problem in the thesis research, namely the vehicle routing problem, the following conclusions can be drawn are the development has been tested using unit verification to ensure the final results. The data processing was then carried out using the genetic algorithm method for

P-ISSN 1858-2680
E-ISSN 2723-4673

the routing problem. The selected optimized result is alternative 1 (one) which produces the shortest distance.

The optimized routes have resulted in a reduction of 3 (three) transportation fleets from the existing total of 6 (six) fleets. This is linear with the total routes produced, where the existing route has 6 (six) routes, and after optimization, it becomes 3 (three) routes based on the genetic algorithm method.

The first route starts from the Samarinda DC (Distribution Center) and goes through KCP Bengkuring - Agent Aidil Azhar - KCP Samarinda Sei Keledang - Agent Agung - KCP Palaran - KCP Anggana - KCP Sangasanga - KCP Samboja - KCP Manunggal Jaya - KCP Samarinda Temindung - Agent Cendana Mitra Perkasa - Agent Septi Wijaya, and then returns to the Samarinda DC.

The second route starts from the Samarinda DC and goes through KCP Samarindaseberang - KCP Samarinda Ilir - Agent Mutiara - KCP Samarindamugirejo - KCP Muara Badak - KCP Samarinda Sei Kunjang - KCP Muarajawa - KCP Loaduri - Agent Family - Agent Abadi Jaya - KCP Sultan Sulaiman, and then returns to the Samarinda DC.

The third route starts from the Samarinda DC and goes through Agent Eldi Sukses Mulia - KCP Sungai Siring - KC Samarinda, and then returns to the Samarinda DC.

Based on the use of the genetic algorithm method, several data processing steps were used to generate the optimized results:

a) Chromosome : 3
b) Population : 26
c) Generation : 100
d) Roulette wheel selection : 5

The results obtained from data processing using the genetic algorithm method resulted in the best solution in the final population with the following fitness and computational values:

Alternatif	Rute	Waktu Komputasi (t)	Fitness
1	1	34 s	128
	2	38 s	127
	3	24 s	37

The optimization results using the genetic algorithm method obtained a total delivery distance of 204.33 km. The details of the distances for each route are the total distance on the first route is 121.71 km. The total distance on the second route is 60.32 km. The total distance on the third route is 22.3 km.

The optimization results from the processing using the genetic algorithm method explain that the total daily cost incurred has decreased by 34% compared to the existing cost. The total transportation cost for the existing route per day is Rp. 1,180,000, while the total transportation cost for the proposed route per day is Rp. 760,000.

Based on the comparison between the existing and proposed costs, if calculated monthly, the total transportation cost per month for the existing route is Rp. 35,400,000, while the monthly cost for the selected proposed route is Rp. 22,800,000.

Bibliography

[1] Azis, R., & Asrul. (2014). Pengantar Sistem dan Perencanaan Transportasi. Yogyakarta: Deepublish

[2] Braysy, O. Gendreau. (2005). “A Fast Local Searches for The Veicle Routing Probelem With Time. INFOR, Vol 40:4, 313.

[3] Bowersox, D.J. (1996). Manajemen Logistik, Bumi Aksara, Jakarta.

[4] Edward W. Smykay, Donald J. Bowersox, and Frank H. Mossman, 2016. Physical Distribution Management, New York: The Macmillan Company. Pp. xiv, 283.

[5] Gendreau, M,. and Potvin, J.Y (eds). 2010. Handbook of Metaheuristics: Second Edition. New York: Springer Science+Business Media

[6] Hadihardaja, Joetata, 1997. Sistem Transportasi. Jakarta : Universitas Guru Darma

[7] Jose Brandao and Alan Mercer. European Journal of Operational Research, 1997, vol. 100, issue 1, 180-191. Date: 1997.

[8] Kamaludin, Rustin. 1986. Ekonomi Transportasi, Jakarta: Penerbit Ghalia Indonesia.

[9] Michael Hugos. 2003. Essentials of Supply Chain Management. John Wiley & Sons, Inc.

[10] Miro, Fidel. 2012, Pengantar Sistem Transportasi, Jakarta: Erlangga.

[11] M.N Kritikos dan G. Loannou, 2013, The Heterogeneous fleet vehicle routing problem with

 P-ISSN 1858-2680
E-ISSN 2723-4673

overloads and time windows, Int. J. Prod. Econ., vol. 144, no. 1, pp. 68– 75, 2013, https://doi.org/10.1016/j.ijpe.2013.01.020

[12] Rahmi Y., & Murti A., (2013). Penerapan Metode Saving Matrix Dalam Penjadwalan Dan Penentuan Rute Distribusi Premium Di SPBU Kota Malang. Jurnal Rekayasa Mesin. vol.04, no.01, hlm. 17-26.

[13] R. Martí, G. Reinelt, dan A. Duarte, "Perpustakaan benchmark dan perbandingan metode heuristik untuk masalah pemesanan linier," Optimasi dan Aplikasi Komputasi, vol. 51, tidak. 3, hal.1297–1317, 2012.

[14] S, Subagya M. (1994). Manajemen Logistik. PT Gunung Agung, Jakarta.

[15] Semet, F., Taillard, E. Solving real-life vehicle routing problems efficiently using tabu search. Ann Oper Res 41, 469–488 (1993). https://doi.org/10.1007/BF02023006

[16] Sinta Uli, 2006, Pengangkutan, Suatu Tinjauan Hukum Multimoda Transpor Angkatan Laut, Angkatan Darat dan Angkatan Udara, Medan : Usu Press

[17] Tamin, OZ., (2008). Perencanaan,Pemodelan, & Rekayasa Transportasi:Teori, Contoh Soal, dan Aplikasi. Bandung: Penerbit ITB.

[18] Toth dan Virgo. (2002). The Vehicle Routing Problem. Philadelphia, SIAM Monographs on Discrete Mathematics and Application.

P-ISSN 1858-2680
E-ISSN 2723-4673