**ROUTE AND TRANSPORTATION COSTS ANALYSIS CONSIDERING THE CITY LOGISTICS SYSTEM FOR SINGLE DEPOT PROBLEM**

**(Case study: Jababeka Industrial Area Companies)**

**Yogi Yogaswara\*)**

Program Studi Teknik Industri

Fakultas Teknik – Universitas Pasundan

**Abstract**: Urban freight transport recently faces many challenging problems, including high levels of traffic congestion, negative environmental impacts,and high energy consumption. Evaluation measures that can be done is by determining the routing and scheduling.PT. TMU was that produces various types of paints which are marketed to companies located in the industrial area of Kabupaten Bekasi and Jakarta. Determination of route by the company on the basis of the views and considerations vehicle payload capacity and usability of the vehicle. This study wasconductedto developthedeterminationthatcan bedone by considering thecarrying capacityand time windows, as well as consideringenvironmental aspects, reducingthe impact ofcongestion, socialaspects, andenergyconsumption. The model usedin the form ofconceptCapacity Vehicle Routing Problem with Time Windows (CVRPTW) approach Savings on application Logware 5.0. This method are used inthe case ofthe VRPby considering thecapacity, andtheminimum cost. The result ofthecalculationaffectssomeaspects include savingsgeneratedmileageof 32.48%,efficiencypayload capacityratio of84.8%,savingtransportation costs27.10, saving tol revenue 54,24%,emission reduction3.85%, and then decrease inthe number ofcitizen complaintsas much as5,22%.

**Keywords:** CVRPTW, Savings Heuristics Algorhitm, City Logistics, Single Depot

1. **INTRODUCTION**[[1]](#footnote-1)

Socio-economically, the city is an environment with economic and the diverse business and is dominated by non-farm business activities include services, trade, transportation and industrial [1]. The rapid development of urban areas in Indonesia could not be separated from the role of logistics. One of the key activities in logistics is on transport, in this case is freight transport.

Problem determination of routing and scheduling are the operational issues in transportation. Studies conducted in PT. TMU are transport operations in logistics. The Company are marketed to companies located in the industrial area of Kabupaten Bekasi and an expedition partner company to be sent to the outer islandsof Java are located in parts of Jakarta

The phenomena that occur in the company related to the transport logistics are expenses incurred from transportation activities undertaken by the company deemed high enough so that it takes the reduction of transport costs in order to save costs incurred by the company. In addition, the lack of good planning related to transportation logistics activities is a phenomenonof the next issue, so the determination of route and cost analysis of transportation before the operation deemed necessary by the company so that the company can carry out the necessary assessment of costs intrans port logistics activities to be performed.

So in this case is necessary to make decisions about who canoptimize the mileage or travel costs, travel time, number of operated vehicles and other resources are available by considering environmental aspects, reducing the impact oft raffic congestion, socialaspects, as well as energy consumption required from the movement of freight transport.

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1. **METHODOLOGY**

Referring to the journal published by Taniguchi and Tamagawa (2005) entitled “*Evaluating City Logistics Measures Considering The Behavior of Several Stakeholders*” [2], There are five categories stakeholders which are in issue in this study include:

1. Freight carrier with criteria transportation cost.
2. Shippers with criteria transport travel time.
3. Urban expressway operators with criteria toll revenue.
4. Residents with criteria total NOx emissions in the network. The residents would make a complaint against the administrators whenever the NOx emissions for their zones exceed 50g per 1km.
5. Administrator with criteria total NOx emissions in the network and Total number of complaints from the residents.

**Table1**

**Details of Consumer**

|  |  |  |
| --- | --- | --- |
| **No.** | **Company Name** | **Demand (kg)** |
| 1 | PT. Astra Daihatsu Motor (Engine Plant) | 1907,4 |
| 2 | PT. Akashi Wahana Indonesia | 53,66 |
| 3 | PT. Walsin Lippo Industries | 113,42 |
| 4 | PT. Sanggar Sarana Baja | 277,6 |
| 5 | PT. Fortuna Indah | 60 |
| 6 | CV. Multi Teknik Bekasi | 76,93 |
| 7 | PT. Cameron Services International | 51,39 |
| 8 | CV. Super Perdana (Expedition Partner) | 1027,75 |
| 9 | PT. Sekawan Maju Bersama (Expedition Partner) | 261,55 |
| 10 | PT. Sekawan Kontrindo (Expedition Partner) | 841,2 |
| 11 | PT. Bintang Anugrah Sehati | 154,09 |
| 12 | PT. Manado Teknik Mandiri (Expedition Partner) | 268,3 |
| Total Demand (kg) | 5093,29 |

**Table 2**

**Data Fixed and Variabel Cost of Vehicle 1**

|  |
| --- |
| Brand/Type of Vehicle : Isuzu NHR 55 Year 2006Pay Load Person (kg) : 120Pay Load Goods (kg) : 2000 |
| Total *Fixed Cost/day* | Rp. 92.674 |
| Total *Variable Cost/km* | Rp. 260 |

**Table3**

**Data Fixed and Variabel Cost of Vehicle 2**

|  |
| --- |
| Brand/Type of Vehicle : Suzuki ST 150 Pickup Year 2013Pay Load Person (kg) : 120Pay Load Goods (kg) : 800 |
| Total *Fixed Cost/day* | Rp. 96.372 |
| Total *Variable Cost/km* | Rp. 61 |

*Source*: Data ProcessingCompanies

City Logistics measures will significantly affect the energy consumption of freight vehicles by improving and rationalising urban freight transport systems. Yamada (1980) was taken from Taniguchi *et al* (2001) developed a model for estimating fuel consumption using on-road test data [3]. Equation 1 is the model equations of the estimated fuel consumption.

*fe =* 6,372 – 0,716*rg* – 0,193*ts*– 1,392*g*a – 1,412*a* + 0,138*V* – 0,001*V2* (1)

where:

fe : fuel economy (km/litre)

*rg* : 1 for gravel road, 0 for asphalt pavement

*ts* : stopped time (min.)

*g*a: average gradient (%)

*a* : 1 when AC is on, 0 when AC is off

*V* : average travel speed (km/jam)

There are numerous undesirable negative effects from urban goods movement that can be present a direct risk to human health. Greenhouse gases produced from exhaust gases of trucks are a major concern in many cities. In this case, the emission factors used in determining the total NOx emissions of pollutants is to use a reference emission factor of the Indonesian Ministry of Environment drawn from scientific journals Srikandi Novianti dan Driejana (2009) entitled “The Influence of Factor Emission Characteristics In Transport-Induced Nitrogen Oxides (NOx) Emission Load Estimation” as can beseen in Table 4.

**Table 4**

**Emission Factor Data in Indonesia**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Category | CO (g/km) | HC (g/km) | NOx (g/km) | PM10 (g/km) | CO2 (g/kg BBM) | SO2 (g/km) |
| Motorcycle | 14 | 5,9 | 0,29 | 0,24 | 3180 | 0,008 |
| Passenger cars (gasoline) | 40 | 4 | 2 | 0,01 | 3180 | 0,026 |
| Passenger cars (diesel fuel) | 2,8 | 0,2 | 3,5 | 0,53 | 3172 | 0,44 |
| Passenger cars | 32,4 | 3,2 | 2,3 | 0,12 | 3178 | 0,11 |
| Bus | 11 | 1,3 | 11,9 | 1,4 | 3172 | 0,93 |
| Truck | 8,4 | 1,8 | 17,7 | 1,4 | 3172 | 0,82 |
| Public Transportation | 43,1 | 5,08 | 2,1 | 0,006 | 3180 | 0,029 |

*Source*: [4], [5]

Then for the decision model of stakeholders level satisfaction city logistics system starts from stage calculation *Capacity Vehicle Routing Problem With Time Windows* (CVRPTW) approach *Clarke* &*Wright Savings Heuristics Algorhitm*.

This method is used for the VRP case by considering the capacity, and the minimum cost route followed by obstacles in the distribution system. In general, the savings equation is shown in Equation (2).

*Sij*=*Da*–*Db*=*ci0*+*c0j*–*cij* (2)



**Figure 1**

**Savings Concept Illustration [5]**

The steps in detail the methods savings as follows:

1. Set the distance at the beginning of each route for each node.
2. Calculate each pair using the savings equation (Equation 2).
3. Create a list ranking of each pair are different.
4. Combine route when possible.
5. Next check back every couple route that have been generated.

General overview of the steps problem solving methodology can be seen in Figure 2 below in the form of a flowchart.



**Figure 2.**

**Methodology**

1. **RESULTS**

The results of this study can be described in the Figure 3 to Figure 10. Figure 3 shows the route plot. Figure 4 presents the comparison of the transportation cost cases. The total emission of NOx can be seen in the Figure 6.

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1. Route Plot



1. Route Result

**Figure 3**

**Route Plot (a) Existing Condition (with 2 vehicles) and**

**(b) Route Result are Built by Logware 5.0 (with 1 vehicle)**

**Figure 4**

**Comparison Chart of Total Transportation Cost**

**Figure 5**

**Comparison Chart ofTransport Travel Time**

**Figure 6**

**Comparison Chart of Total Toll Revenue**

**Figure 7**

**Comparison Chart of Total NOx Emissions**

**Figure 8**

**Comparison Chart The Number of Residents Complaint**

|  |  |
| --- | --- |
| (a) | (b) |

**Figure 9**

**Illustration of Road Network Number of ComplaintsResidents**

**(a) Case1 and (b) Case 2**

**Figure10**

**Comparison Chart of Performance Level**

1. **CONCLUSION**

Results calculated by Clarke and Wright Savings Algorithm approach using application Logware 5.0 obtained 3 route of distribution that can be done by the company include:

1. First route with the consumer point 0–1–2 –0 by distance 66.9km hauling total demand as much as1961.06kg,
2. Second route with the consumer point 0 – 3 – 5 – 9 – 12 – 10 – 0 by distance114km hauling total demand as much as1544,47 kg, and
3. Third route with the consumer point 0 – 7 – 6 – 4 – 11 – 8 – 0 by distance123.9km hauling total demand as much as1587.76 kg.

Where the whole targeted of node consumers using the vehicle in the form of a single ankle truck axis configuration with 1-1 (4 wheel). Furthermore, the data processing is done affects many aspects. These aspects include:

1. Savings generated mileage of 146.6km (32.48%) so that an increase in the level of performance with the actual conditions of 1.48.
2. Efficiency pay load capacity ratio (occupancy rate) of 84.8% where there is a difference in the numbers with the existing conditions in the company amounted to 9.44% so that an increase in performance level of 1.17.
3. Savings transportation costs Rp. 221,746 (27.10%) so that an increase in performance level of 1.38 and savings toll revenue Rp. 48,000 (54.24%) with the increase in performance level of 1.84.
4. Transport travel time during 610 minutes with the decrease in performance level of 0.80, where the difference of time with the actual conditions which produced for 119 minutes. Although there is a resulting decrease in the level of performance, but it does not happen constraints exceeds a predeterminedof time windows.
5. Reduction of NOx emission 216.27 gram (3.85%) with the increase in performance level of1.04,
6. Decrease in the number of complaints residents as much as 6 times (5.22%) with the increase in performance level of 1.06.
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1. Staf pengajar Prodi Teknik Industri UNPAS

e-mail: yogiyoga@unpas.ac.id [↑](#footnote-ref-1)