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The 3rd International Forum and Conference on Logistics and Supply Chain Management (LSCM) 2013

Editors
Siana Halim
I Gede Agus Widyadana

Proceeding

The 3rd International Forum and Conference on Logistics and Supply Chain Management (LSCM) 2013

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MESSAGE FROM THE ORGANIZERS

The 3rd International Forum & Conference on Logistics and Supply Chain Management (LSCM) 2013 will be held by the Industrial Engineering Department, Petra Christian University with Takming University of Science and Technology as an international forum and conference for disseminating to all branches of industries, information on the most recent and relevant research, theories and practices.

Following the earlier LSCM conferences, the LSCM 2013 will be held in Bali (Indonesia) on 27-29 June 2013. The conference will link researchers and practitioners from different branches of Logistics, Supply Chain and Industrial Engineering.

The call for papers has attracted 100 abstracts from more than seven countries. After careful review by the program committee, 59 finals papers will be included in the proceedings.

The programmed has been organized into a set of groups, each representing papers covering the latest developments in their subjects. We are indebted to our authors for their ideas and concepts reflected in their paper. We are honored by our distinguished keynote speakers, for sharing their insights with us. We thank to our reviewers who helped us to select the papers for this conference.

We hope the conference will offer a useful platform for the exchange of ideas and experiences.

Felecia
General Chair

I Gede Agus Widyadana
Organizing Committee Chair

CONFERENCE ORGANISATION

The Conference and Organizing Committee Chairs wish to thank members of the Organizing Committee and Program Committee for the contributions in organizing this Conference

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CONFERENCE SCHEDULE

27 June 2013

08.30 – 09.00	Registration
09.00 – 09.05	Welcoming
09.05 – 09.15	Opening Speech
09.15 – 10.45	Keynote Speaker 1 (Kresnayana Yahya, M.Sc)
10.45 – 11.00	Coffee Break
11.00 – 12.30	Keynote Speaker 2 (Prof. Hui Ming Wee)
12.30 – 13.30	Lunch
13.30 – 15.00	Parallel Session 1
15.00 – 15.15	Coffee Break
15.00 – 16.30	Parallel Session 2
18.00 – 21.00	Gala Dinner

28 June 2013

09.00 – 10.30	Keynote Speaker 3 (Prof. Mamun Habib)
10.30 – 10.45	Coffee Break
10.45 – 11.30	Parallel Session 3
11.30 – 13.00	Lunch
13.00 – 14.45	Parallel Session 4
14.45 – 15.00	Coffee Break
15.00 – 16.45	Parallel Session 5

29 June 2013

Conference Tour

CONFERENCE LIST OF PAPERS

Garbage Trucks' Routing in Surabaya

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Abstract: Garbage is produced daily in Surabaya. This work aims to find the effective garbage-collecting route in order to free Surabaya from garbage pile. Several factors needed to be examined are existing garbage colleting system and transportation time by traffic condition. Using this information, a model of Vehicle Routing Problem is developed. The model is called Time-dependent Vehicle Routing Problem with Multiple Trips and Intermediate Facility (TDVRPMTIF).Routes are applied to 70 trucks for 97 Temporary Dumping Site (TPS) in Surabaya, which consists of 19 locations in Central Surabaya, 15 locations in West Surabaya, 15 locations in North Surabaya, 36 locations in East Surabaya, and 12 locations in South Surabaya. The completion of garbage collection route TDVRPMTIF is using sequential insertion algorithm in 3 variants working time, 8-hours, 9-hours and 10-hours. These 3 variants working time do not produce less total routes assigned to the truck. This indicates Surabaya's garbage collection have insufficient quantity of trucks to complete the problem.Several alternatives are proposed to solve the problem. First alternative is maintaining 8-hours working time and adding 11 trucks to complete the task. Second choice is adjusting the working time to 9 hours with the addition of 7 trucks. The third one is optimizing the existing 70 trucks with 10-hours working time.

Keywords:Vehicle Routing Problem, multiple trips, intermediate facility, time-dependent, sequential insertion algorithm.

Introduction

Vehicle Routing Problem (VRP) is a classical problem, which was proposed, by Dantzig and Ramser in 1959 [1]. It is an important problem in the fields of transportation, distribution and logistics. Many methods have been developed for searching good solutions, in terms of finding global minimum for the cost function. From the several variations of the vehicle routing problem, we are interested in the time dependent vehicle routing problem, which was developed at the first time by Malandraki and Daskin [6]. Since the exact solution of this problem is complicated, there are many heuristic solutions offered to break through that difficulty. Toth and Vigo [8] gave a good summary of problem formulations, variants, exact and heuristics solutions of the vehicle routing problem.

Some applications of the VRP are given by Tung and Pinnoi [9], which modeled the VRP for waste collection in Hannoi; Fitria *et al.* [4], which applied the VRP with multiple trips and intermediate facility to schedule the garbage truck route in Bandung; Priyandari *et al.* [7] applied the VRP to schedule the fertilizer distribution in Karanganyar. In this work we follow the Fitria *et al.* [4], with additional time-dependent in the formulated problem.

Many heuristics approach were proposed to solve the variants of that method. Khanh *et al.*[5] proposed a tabu search for time dependent VRPMT with time window. Donati *et al.* [2] proposed time dependent VRP with a multi ant colony system. Here, we follow Dullaert [3] using the insertition method for solving this problem.

The Condition of Garbage Collected Procedure in Surabaya

Surabaya is divided into 5 regions, namely Central East, West, South, and North. Garbage collection in Surabaya is not only done by the government, but also by the private sector. Government manages garbage collection in 158 Temporary Dumping Site (TPS) across Surabaya. There are 3 types of garbage collection system, using armroll 14 m3, armroll 8 m3, and dumping. In this paper, we are focusing on TPS that using roll arm14 m3.

Garbage collection with roll arm is quite simple. Container placed in TPS then filled trash from garbage carts. Replacement containers are made every day, and some done 2 times daily depending on whether the container has been filled. In some TPS, The garbage collections are not routine every day but depend on reports from the TPS. If the container is filled with garbage, TPS will communicate to the station/depo and the truck will be sent to TPS. Only full container has to be taken out and replaced with an empty container and the garbage will take to the landfill site. Then the truck will go to next location for next garbage collection. This activities running until the end of working hours and the truck back to the station.

Based on waste transportation system that already done by Landscape and Sanitation Department Surabaya, it can be said that the first route is the route the truck done Station to TPS, then TPS to waste disposal site/landfill (TPA), TPA to TPS, and to end the route TPA-Station.

Garbage collection model is different from the normal models Vehicle Routing Problem. In this model after garbage collection is done, the waste must be collected in advance on TPA dismantled before the truck back to the base, whereas in normal VRP truck models directly back to the base when it has passed all the assigned location. Model developed in this study is the Vehicle Routing Problem with Intermediate Facility. Coupled with the possibilities of multiple trips that are occurred in 1 day and a time-dependent on time, then the final model of garbage collection in Surabaya is the Time-Dependent Vehicle Routing Problem with Multiple Trips and Intermediate Facilities.

Methods

TDVRPMTIF model is a model of transport in accordance with the waste collection system Surabaya and used in this study. Some notations which have been established like a base truck station, TPS as a customer, as an Intermediate Landfill Facility, trucks as vehicles, and implemented within the time limit T. Notation used in the model of waste transport in Surabaya.
Trucks as a base stationt (0)
TPS as a customer (Loc = 1,2,3, ..., n)
TPA as Intermediate Facility (inf)
Working hours as T

Characteristics Model

Objective function (Z) from Surabaya city waste transport models is to minimize the total time and the use of trucks to transport garbage from polling stations to the landfill, which is formulated as follows.

$$Z = \min (\Sigma \text{total\_time}) \quad (1)$$

Where, total_time is the time required by each truck to complete the assigned route. Total of variable time containing some kind of time which is formulated as follows.

$$\text{total\_time} = \Sigma \text{CompletionTime} + \text{TPA-Station} \quad (2)$$

$$\text{CompletionTime} = \text{PickupTime} + \text{LoadingTime} + \text{Deliverytime} + \text{UnloadingTimeEstimationTime} \quad (3)$$

Completion Time is the time to complete a task, including leave and come back, or the so-called round-trip (PP). Completion Time consists of Pickup Time, Loading Time, delivery time, and Unloading Time. Pickup Time is the time it takes to go to the polls. Loading Time is the time required to lower the empty container to the polls and raise container that is full to the top of the truck. Delivery time is the time it takes to transport the waste from the polling stations to the landfill. Unloading Time is the time required to lower the load on landfill waste. In addition to the above fourth time, Completion time also coupled with Estimation Time which is the time it takes to pass the vulnerable road congestion depends on the intended route.

Notation and Mathematical Model

Notation and mathematical models were developed according to this model notation and mathematical models in the journal Truck Route Determination Waste Collection and Transportation in Bandung by Fitria *et al.*[4]

Notation	
i	location index
r	route index
X	rotation index
K	position index
NR	number of route
$NX[r]$	number of ritation in route r
$NL[r,x]$	number of positions in the ritation r, x
$L[r,x,k]$	location in route r, rotation, x position, k
$\alpha[r,x,k]$	arrival time in k position x rotation r route
$\delta[r,x,k]$	arrival time route r, rotation, x position, k
$d[L[r,x,k],L[r,x,m]]$	Distance between route r, rotation, x position, k and position m
V_t	Speed to pass congestion-prone roads at t
μ_t	average velocity at time t
σ_t	Standard deviation at time t
$e[t]$	Time passes congestion-prone roads at t
$\tau[L[r,x,k],L[r,x,m]]$	The travel time between route r, rotation, x position, k and position m
$CT\,[r]$	Time to accomplish route r
s	*Loading time*
h	*Unloading time*
T	length of the planning horizon
NV	The number of vehicles

Some restrictions are used for the completion of the model:

$$L\ r,x,1\ = 0, r = 1,\dots,NR; x = 1 \quad (4)$$

$$L\ r,x,NL\ r,x\ -1\ = i, \quad (5)$$
$$r = 1,\dots,NR; x = 1,\dots,NX\ r\ , i = inf$$

$$L\ r,x-1,NL\ r,x-1\ = i, \quad (6)$$
$$r = 1,\dots,NR; x = 2,\dots,NX\ r\ , i = inf$$

$$L =\ r,x,1\ = i \quad (7)$$
$$r = 1,\dots,NR; x = 2,\dots,NX\ r\ , i = inf$$

$$L\ r,x,NL\ r,x\ = i \quad (8)$$
$$r = 1,\dots,NR; x = 1,\dots,NX\ r\ ; i = 0$$

$$L\ r,x,k\ = i \text{with} L\ r,x,k\ \neq L[r,x,m] \quad (9)$$
$$r = 1,\dots,NR; x = 1,\dots,NX\ r\ ; k,m = 1,\dots,NL\ r,x\ -2, i = 1,\dots,n$$

$$\delta\ r,x,k\ = 0 \quad (10)$$
$$r = 1,\dots,NR; x = 1; k = 1$$

$$\delta\ r,x,k\ = \alpha\ r,x,k\ + s \quad (11)$$
$$r = 1,\dots,NR; x = 1,\dots,NX\ r\ ; k = 2,\dots,NL\ r,x\ -2$$

$$\delta\ r,x,k\ = \alpha\ r,x,k\ + h \quad (12)$$
$$r = 1,\dots,NR; x = 1,\dots,NX\ r\ ; k = 2,\dots,NL\ r,x\ -1$$

$$V_t \sim N(\mu_t, \sigma_t) \quad (13)$$

$$\mu_t = \begin{matrix} \mu_{t1} t_1 = 08.00 - 09.00 \\ \mu_{t2} t_2 = 09.00 - 13.00 (14) \\ \mu_{t3} t_3 = 13.00 - 16.00 \end{matrix}$$

$$\sigma_t = \begin{matrix} \sigma_{t1} t_1 = 08.00 - 09.00 \\ \sigma_{t2} t_2 = 09.00 - 13.00 (15) \\ \sigma_{t3} t_3 = 13.00 - 16.00 \end{matrix}$$

$$e[t] = \frac{d[L[r,x,k], L[r,x,m]]}{V_t} \quad (16)$$

$$\delta\ r,x,k\ = \alpha\ r,x,k\ + \tau\ L\ r,x,k\ , L\ r,x,k\ + e[t\ L\ r,x,k\ , L\ r,x,m\ ] \quad (17)$$
$$r = 1,\dots,NR; x = 1,\dots,NX\ r\ ; k = 2,\dots,NL\ r,x\ -1$$

$$CT\ r\ \leq PH \quad (18)$$
$$CT\ r\ = {}_{x=1}^{NX\ r\ -2}\ {}_{k=1}^{NL\ r,x\ -1} \tau\ L\ r,x,k\ , L\ r,x,k + 1\ + {}_{x=1}^{NX\ r\ -2}\ {}_{k=1}^{NL\ r,x\ -1} e\ \ t\ L\ r,x,k\ , L\ r,x,m\ + s + h \quad (19)$$

$$NV = NT \quad (20)$$
$$TCT = {}_{r=1}^{NR} CT\ r \quad (21)$$

Equation (4) ensures the vehicle departs from Station first time. Equation (5) guarantees for unloading vehicles visiting the landfill. Equation (6) ensures the vehicle to the landfill after ritasi. Equation (7) ensures the vehicle departs from the landfill to the next ritasi on one day. Equation (8) ensures route ends at the stationt. Equation (9) ensures the TPS is only visited once. Equation (10) shows the truck set off for the first time from the stationt at time 0. Equation (11) shows the departure of the truck at a site is the sum of the time of arrival of the truck at the location of the loading time. Equation (12) applies only to the landfill showing the departure time of TPA is the sum of the time the truck arrived at the landfill with the unloading time. Equation (13) shows that the speed of the truck as it passes through the normal berditribusi prone to congestion depends on the average speed (μt) and standard deviation (σt) at time t. Equation (14) shows the variation of the average velocity (μt) is there. Equation (15) shows the variation of standard deviation (σt) is there. Equation (16) shows that the estimated time to pass the vulnerable road congestion is the quotient of the distance between the location of the velocity at time t. Equation (17) shows the time of arrival of the truck at a given location is the sum of the time of departure at the previous location of the travel time and travel time for congestion-prone roads. Inequality (18) shows the completion time is between the hours of employment. Equation (19) shows the elements for the completion time of a route, the travel time between locations, travel time for road prone to congestion, time of loading, and unloading time. Equation (20) to determine the number of trucks that being used. Equation (21) determines the total completion time.

Surabaya city garbage truck routes are determined based on the new time to cover the distance to the base instead of the previous location which is 1 truck is responsible for a specific location. Division of routes based on the location of the lead time required to get to a location is not optimal. For example look at the Tanjung Sari and Suko Manunggal. The time it takes to the TPS Tanjung Sari would be minimal if taken from the depo/station rather than taken from the landfill. The secnd to the early lead ritation TPS Tanjung Sari starts from waste landfill. Therefore, the basis for determining that the new garbage trucks converted to travel time to get results quicker route.

This model also uses the principle of the time-dependent variation lies in the travel time to a TPS based congestion-prone roads are impassable. The time to complete one route called CompletionTime. Completion Time consists of Pickup Time, Loading Time, Unloading Time, deliverytime, and Estimation Time. Completion Time will vary depending on Estimation Time, which is the travel time of the truck through the streets prone to congestion. Congestion-prone roads are taken into account there are 3, Margomulyo, Tandes-Dupak high way, and A. Yani.

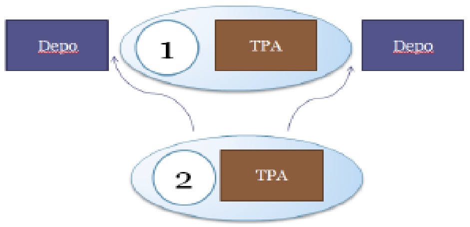

Figure 1. Sequential Insertion method

Each TPS passed different congestion-prone roads. Time truck up in road congestion prone (t) in question will make the truck travel time varies as reflected in Estimation Time.

Here are the steps in determining the route of work trucks:

Step 1
Enter the distance TPS-TPA, TPA-TPS, and Station-TPS. Based on the three kinds of distances, distances obtained TPA-Margomulyo, Margomulyo-Ahmad Yani, Margomulyo-TPS, TPS Ahmad Yani, and Toll-TPS. The distances will be used in determining the best route depending on the location of polling stations and roads as well as the hours passed.

Step 2
Make the initial, R = [0], which means the truck start of the stationt.

Step 3
Choosing the best TPS is based on the distance to the stationt. TPS has the closest distance to the station will be assigned the first time. For example, the selected TPS is TPS Tanjung Sari (26). Existing routes modified to be R = [0 26 inf]. These means the truck start of Station (0) heading to the polls Tanjung Sari (26), and then transport the waste to landfill (inf). If a location has been assigned, the site will be deleted.

Step 4
Calculate travel time (total_time) for the assigned route by considering time-dependent. Then t check, adjust Estimation Time with t to obtain the travel time.

Step 5
Check whether another location if one is assigned, the time will exceed the working hours. If not, then the other locations will be assigned based on step 6. If the time exceeds hours of work, will do step 7.

Step 6
Choose the best location based on the distance to the landfill. If a location has been assigned, the site will be deleted. TPS is selected will be processed with Sequential Insertion method to get the best order in the next polling place. Sequential

Table 2. Route example

No	Location 1	Location 2	Location 3	Time Hours	Time Mi
1	Balongsari	Bangunsari		6	43
2	Manukan Kulon	Manukan Kulon	Suko manunggal	7	9
3	Candi Lontar	Tanjung Sari	Suko manunggal	7	0

Table 3. Each comparison of working time

	Working time		
1	8 hours	9 hours	10hours

Insertion principle of the method is described in the next paragraph. Return to step 5.

Step 7
Trucks will be returning to the stationt. Routes will be modified to be R = [0 ... inf 0]. Next create another route for trucks to repeat step 2 until all locations have been assigned.

Sequential Insertion working step method:

Step 1
Getting the initial route and location will be placed. Illustrations can be seen in Figure 1.

Step 2
The new location can be placed in 2 alternative venues, in one location after Depo/station before or after the location 1. Location and TPA is a unity because after taking the garbage trucks in one location, the truck should go to the landfill to dispose of garbage in the container. After taking out the trash, the new truck can go to the next location.

Step 3
The existence of two alternative placements made there are 2 alternative routes, namely R1 = Station - 2 - TPA - 1 - Landfill Stationts and R2 = Station - 1 – TPA - 2 - TPA - Station.

Step 4
The alternative route is calculated total_waktu by considering time-dependent and compared. If R1 is better, then the selected R1.If R2 is better, then the selected R2.

Step 5
Routes that have been selected will be the initial route for the next iteration. If the heading should run into more than one line, the run-over should be flushed left.

Results and Discussion

After entering all the data into the program, obtained 82 new routesfor the 8-hours working time. Upon further analysis, it was found that there are several routes exceed the specified working hours, or far less than an hour work. These routes are then routed back to get a more effective service. After rerouting, obtained 81 new routes.

to read routes are Depo/Station - Location 1 - TPA - Location 2 - TPA - Area 3 - Depo. Route always starts and ends at the depo. After hauling trash in one location, the truck will go directly to the landfill.

Because the determination of the 8-hour working time using the Sequential Insertion provide service that exceeds the number of available truck capacity, the necessary adjustments to the hours of work trucks. Adjustments made to working hours 9 hours and 10 hours. Initial conditions that TPA-Depo travel time does not include the specified working hours and there is tolerance time 1 hour after working hours to facilitate the time the truck back from the landfill to remain valid Depo.

The final result was 81 for the 8-hour working time, 77 working hours service for 9 hours, and 70 routes to 10 hours working time. The numbers of routes that can be caused by many landfill sites are so far from the polling stations and adjacent to the depot. Options for the truck transportation of municipal solid waste Surabaya has 3 alternative working hours depend on the number of trucks available. If the time to maintain current employment, and Sanitation Department should increase the number of trucks available. When choosing to change work hours, counseling should be done in order to know the truck driver hours of work assigned to them. The addition of salary does not happen because the current truck driver has 24 hours standby.

Conclusion

Based on the analysis and the results of past studies, it can be concluded basis for determining the change of location to the effective time of the assignment does not affect the reduction in truck. This shows the actual transport of Surabaya city garbage truck fleet shortages within hours to perform the available work.

Some alternatives are given to resolve the issue. The first alternative is to maintain the working hours for 8 hours and add 11 trucks transporting waste to complete the route. The second alternative is to adjust working hours to 9 hours with the addition of smaller trucks with 7 trucks. The third alternative is to use existing truck with working hours of 10 hours.

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