

# 39-2013-The preprocessing- IJAAS

*by Irmeilyana Irmeilyana*

---

**Submission date:** 05-May-2023 03:39PM (UTC+0700)

**Submission ID:** 2084921269

**File name:** 39.The\_preprocessing\_and\_probing\_technique\_-2013.pdf (225.83K)

**Word count:** 3626

**Character count:** 16646

## **The Preprocessing and Probing Technique of Open Capacitated Vehicle Routing Problem with Split and Time Deadline (OCVRP-St) Model In Rubbish Transportation Problem**

**4** Irmeilyana, Fitri Maya Puspita, Indrawati, Fitra Nur Azizah  
Department of Mathematics, Faculty of Mathematics and Natural Sciences, Sriwijaya University, Inderalaya, South Sumatera, Indonesia

---

### Article Info

#### Article history:

Received May 12, 2013  
Revised Jul 7, 2013  
Accepted Jul 26, 2013

#### Keyword:

Open Capacitated Vehicle Routing Problem (OCVRP)  
Optimal routes  
Preprocessing technique  
Probing technique

### ABSTRACT

The activity of rubbish transportation in Palembang is one of the applications of *Vehicle Routing Problem* (VRP) in transporting rubbish in Sako Palembang by applying preprocessing and probing techniques to obtain simplest OCVRP model. The solution is conducted by using LINDO software. The results show that the optimal routes in Sukarami before and after applying the techniques are the same routes. In addition, we obtain the reduction of constraints and variables, the reduction of iteration numbers and the optimal value did not change.

**1**  
Copyright © 2013 Institute of Advanced Engineering and Science.  
All rights reserved.

### Corresponding Author:

**4** Fitri Maya Puspita,  
Department of Mathematics,  
Faculty of Mathematics and Natural Sciences, Sriwijaya University,  
Inderalaya, South Sumatera, Indonesia.  
Email: pipit140201@yahoo.com.au

---

## 1. INTRODUCTION

Rubbish problem is a major problem in a city that should be handled by the government especially by Dinas Kebersihan dan Pemakaman (DKP). The rubbish disposal in Palembang is conducted into steps. The rubbish were collected from homes to the nearest Temporary Rubbish Disposal (TRD). Then, the rubbish will be transported by the officers from Palembang Hygiene Service Unit by using vehicles such as dump trucks or amroll to Final Rubbish Disposal (FRD) or depot in Sukawinatan or Karya Jaya. The rubbish transportation is grouped into Working Area for each driver of vehicle.

The rubbish transportation is one of the example of *Vehicle Routing Problem* (VRP) to find minimum routes. If it is focussed on one depot and general vehicle capacity, then it is called *Capacitated Vehicle Routing Problem* (CVRP). If the customers can be visited clockwise or anti clockwise routes along the arcs, then the problem is called *Symmetric Capacitated Vehicle Routing Problem* (SCVRP).

In the classic VRP, the vehicles should go back to the depot after finishing the journey. However, in more improved case, after finishing the journey, the vehicles need not to go back to the depot. This will result in open path where the vehicle starts from the depot and ends in one of the customers [1]. That situation occurs in rubbish transportation in Palembang. The vehicles usually are not in depot after transporting the rubbish. The routes will be open routes and we call it Open *Capacitated Vehicle Routing Problem* (OCVRP). If we focus on one depot and the capacity of the vehicles then the problem will be Open Capacitated Vehicle Routing Problem (OCVRP).

Savelsbergh [2] gave detail explanation about tightening the relaxed Linear Program in Mixed Integer Linear Program (MILP) by utilizing *probing* and *preprocessing* techniques which result in the reduction in bounds and size of coefficient of constraint matrices. In this case, Savelsbergh [2] generate the framework to draw various techniques preprocessing and probing in MILP so that set of the feasible solutions of relaxed linear programming can be reduced but the set of the feasible solutions of MILP will not change.

In fact, the probing and preprocessing technique basically attempt to check and change a formulation of the constraints so that that formulation can be solved easily. For instance, in real case of Fixed-Charge Network Flow Problems [3]. The preprocessing technique is already applied in previous research on CVRP [4]-[9].

So, in this paper, the contribution will be based on applying *probing* and *preprocessing* of OCVRP especially for identifying nonfeasible constraints, redundant variables, improving bounds and coefficient and arrangement of variable values. We then validate the model and compare to initial model. He rubbish transportation model is focused on rubbish transportation in Kecamatan Sako Palembang.

## 2. RESEARCH METHOD

To simplify the model of that transportation system, we conduct three stages as follows.

### 1. Form the OCVRP model

The model is formed according to rubbish transportation data in Kecamatan Sako Palembang such as routes, distance between FRD and TRDs, vehicle's capacity, number of vehicles used and rubbish volume. We obtain the data through surveying and interviewing in details' to staff of rubbish management in FRD of Sukabangun area and several drivers of rubbish trucks.

### 2. Simplify the OCVRP model

To simplify the model, we conduct steps such as strengthening the bounds of constraint variables, eliminating redundant constraints and fixing variables.

### 3. Solve the OCVRP model

The solution is to obtain optimal objective function and each decision variables of the model. The solution is based on non-simplified model and simplified model and we seek to compare that simplified model yield efficient result.

## 3. RESULTS AND ANALYSIS

In this part, we describe the steps of simplifying OCVRP model using preprocessing techniques.

### For Working Area 1 Sako

Model OCVRP after setting up the probing technique is

$$\text{Min } z = 6,5y_{01} + 2y_{02} + 6y_{03} + 8,5y_{04} + 8,5x_{12} + 13,5x_{13} + 15x_{14} + 8,5x_{21} + 4x_{23} + 6,5x_{24} + 13,5x_{31} + 4x_{32} + 2,5x_{34} + 15x_{41} + 6,5x_{42} + 2,5x_{43} \quad (1)$$

Subject to

$$x_{12} + x_{13} = 1 \quad (2a)$$

$$y_{03} + y_{30} = 1 \quad (4a)$$

$$x_{31} + x_{32} = 1 \quad (4b)$$

$$y_{04} + y_{40} = 2 \quad (5a)$$

$$y_{01} + y_{02} + y_{03} + y_{04} + y_{10} + y_{20} + y_{30} + y_{40} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 4,2 \quad (6)$$

$$y_{10} + y_{20} + y_{30} + y_{40} - y_{01} - y_{02} - y_{03} - y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 0 \quad (7)$$

$$y_{10} + y_{20} + y_{30} + y_{40} = 1 \quad (8)$$

Nonnegativity requirements:

$$x_{12} \geq 0 ; x_{13} \geq 0 ; x_{14} \geq 0 ; x_{21} \geq 0 ; x_{23} \geq 0 ; x_{24} \geq 0 ; x_{31} \geq 0 ; x_{32} \geq 0 ; x_{34} \geq 0 ; x_{41} \geq 0 ; x_{42} \geq 0 ; x_{43} \geq 0 ; y_{01} \geq 0 ; y_{02} \geq 0 ; y_{03} \geq 0 ; y_{04} \geq 0 ; y_{10} \geq 0 ; y_{20} \geq 0 ; y_{30} \geq 0 ; y_{40} \geq 0$$

$$x_{12}, x_{13}, x_{14}, x_{21}, x_{23}, x_{24}, x_{31}, x_{32}, x_{34}, x_{41}, x_{42}, x_{43} \in \{0, 1, 2\}$$

$$y_{01}, y_{02}, y_{03}, y_{04}, y_{10}, y_{20}, y_{30}, y_{40} \in \{0, 1\}$$

We continue to preprocessing technique as follows.

$$x_{12} + x_{13} \leq 1 \quad (2a^*)$$

$$y_{03} + y_{30} \leq 1 \quad (4a^*)$$

$$x_{31} + x_{32} \leq 1 \quad (4b^*)$$

$$y_{04} + y_{40} \leq 1 \tag{5a*}$$

$$y_{10} + y_{20} + y_{30} + y_{40} \leq 1 \tag{8*}$$

**Preprocessing Technique**

**1. Strengthen the bounds of constraint variables**

$x_{12}, x_{13}, x_{14}, x_{21}, x_{23}, x_{24}, x_{31}, x_{32}, x_{34}, x_{41}, x_{42}, x_{43} \in \{0, 1, 2\}$  dan setiap variabel mempunyai batasan nonnegatif  $\geq 0$ , maka, apabila dimisalkan  $x_{12}=0; x_{13}=1; x_{14}=0; x_{21}=2; x_{23}=0; x_{24}=0; x_{31}=1; x_{32}=0; x_{34}=0; x_{41}=0; x_{42}=1; x_{43}=2, y_{01}, y_{03}, y_{04}, y_{10}, y_{20}, y_{30}, y_{40} \in \{0, 1\}$  dan setiap variabel mempunyai batasan nonnegatif  $\geq 0$ , maka, dimisalkan  $y_{01}=1; y_{02}=1; y_{03}=1; y_{04}=1; y_{10}=0; y_{20}=0; y_{30}=0; y_{40}=1$ .

- Strengthen the bound for variable  $x_{12}, x_{13}$  in (2a\*).
- Strengthen the bound for variable  $y_{03}, y_{30}$  in (4a\*).
- Strengthen the bound for variable  $x_{31}, x_{32}$  in (4b\*).
- Strengthen the bound for variable  $y_{04}, y_{40}$  in (5a\*).
- Variable  $y_{01}, y_{02}, y_{03}, y_{04}, y_{10}, y_{20}, y_{30}$  and  $y_{40}$  in (6) cannot be strengthened.
- Variable  $x_{12}, x_{13}, x_{14}, x_{21}, x_{23}, x_{24}, x_{31}, x_{32}, x_{34}, x_{41}, x_{42}$  and  $x_{43}$  in (6) cannot be strengthened.
- Variable  $y_{10}, y_{20}, y_{30}, y_{40}, y_{01}, y_{02}, y_{03}, y_{04}, x_{12}, x_{13}, x_{14}, x_{21}, x_{23}, x_{24}, x_{31}, x_{32}, x_{34}, x_{41}, x_{42}, x_{43}$  in (7) cannot be strengthened.
- Strengthen the bound for variable  $y_{10}, y_{20}, y_{30}, y_{40}$  in (8).

**2. Eliminate Redundant variables**

**For Constraint (6)**

- a. We got the nonnegative bound after strengthening the bound that are  $x_{12} \geq 0; 0 \leq x_{13} \leq 1; x_{14} = 0; x_{21} = 2; x_{23} = 0; x_{24} = 0; 0 \leq x_{31} \leq 1; x_{32} \geq 0; x_{34} = 0; x_{41} = 0; x_{42} = 1; x_{43} = 2; y_{01} = 1; y_{02} = 1; 0 \leq y_{03} \leq 1; 0 \leq y_{04} \leq 1; y_{10} = 0; y_{20} = 0; y_{30} \geq 0; 0 \leq y_{40} \leq 1$ . By using upper bound, we obtain that (6) satisfy the upper bound of nonnegativity constraint.
- b. We got the nonnegative bound after strengthening the bounds that are  $x_{12} = 0; x_{13} = 1; x_{14} = 0; x_{21} = 2; x_{23} = 0; x_{24} = 0; x_{31} = 1; x_{32} = 0; x_{34} = 0; x_{41} = 0; x_{42} = 1; x_{43} = 2; y_{01} = 1; y_{02} = 1; y_{03} = 1; y_{04} = 1; y_{10} = 0; y_{20} = 0; y_{30} = 0; y_{40} = 1$ . By using lower bound, we obtain that (6) satisfy the lower bound of nonnegativity constraint. We conclude that (3.6) is redundant. Hence, we can eliminate (6).

**For Constraint (7)**

We obtain that (7) satisfy the upper bound and lower of nonnegativity constraint. Hence, it can be eliminated since it is redundant.

**3. Fix the variables**

- a. **Evaluate variable  $x_{13}$ .** Since the constraint (2a\*) has the number of biggest constraints exceed RHS, then that constraint should be eliminated.
- b. **Evaluate variable  $x_{31}$ .** Since the constraint (4b\*) has the number of biggest constraints exceed RHS, then that constraint should be eliminated.

We obtain new OCVRP model as follows.

$$\text{Min } z = 6,5 y_{01} + 2 y_{02} + 6 y_{03} + 8,5 y_{04} + 8,5 x_{12} + 13,5 x_{13} + 15 x_{14} + 8,5 x_{21} + 4 x_{23} + 6,5 x_{24} + 13,5 x_{31} + 4 x_{32} + 2,5 x_{34} + 15 x_{41} + 6,5 x_{42} + 2,5 x_{43} \tag{1*}$$

Subject to

$$x_{12} \leq 1 \tag{2a**}$$

$$y_{03} + y_{30} \leq 1 \tag{4a*}$$

$$x_{32} \leq 1 \tag{4b**}$$

$$y_{04} + y_{40} \leq 2 \tag{5a*}$$

$$y_{10} + y_{20} + y_{30} + y_{40} \leq 1 \tag{8*}$$

and

$$x_{12} \geq 0; 0 \leq x_{13} \leq 1; x_{14} = 0; x_{21} = 2; x_{23} = 0; x_{24} = 0; 0 \leq x_{31} \leq 1; x_{32} \geq 0; x_{34} = 0; x_{41} = 0; x_{42} = 1; x_{43} = 2; y_{01} = 1; y_{02} = 1; 0 \leq y_{03} \leq 1; 0 \leq y_{04} \leq 1; y_{10} = 0; y_{20} = 0; y_{30} \geq 0; 0 \leq y_{40} \leq 1.$$

$$x_{12}, x_{13}, x_{14}, x_{21}, x_{23}, x_{24}, x_{31}, x_{32}, x_{34}, x_{41}, x_{42}, x_{43} \in \{0, 1, 2\}$$

$$y_{01}, y_{02}, y_{03}, y_{04}, y_{10}, y_{20}, y_{30}, y_{40} \in \{0, 1\}$$

**We transform into initial form as follows.**

$$\text{Min } z = 6,5 y_{01} + 2 y_{02} + 6 y_{03} + 8,5 y_{04} + 8,5 x_{12} + 13,5 x_{13} + 15 x_{14} + 8,5 x_{21} + 4 x_{23} + 6,5 x_{24} + 13,5 x_{31} + 4 x_{32} + 2,5 x_{34} + 15 x_{41} + 6,5 x_{42} + 2,5 x_{43} \tag{9}$$

Subject to

$$\begin{aligned}
 x_{12} &= 1 & (10) \\
 y_{03} + y_{30} &= 1 & (11) \\
 x_{32} &= 1 & (12) \\
 y_{04} + y_{40} &= 2 & (13) \\
 y_{10} + y_{20} + y_{30} + y_{40} &= 1 & (14)
 \end{aligned}$$

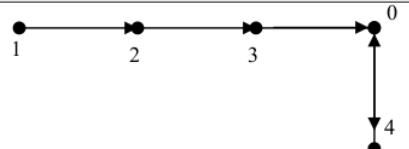
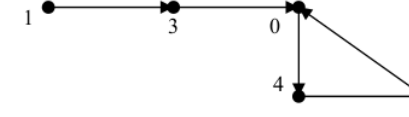
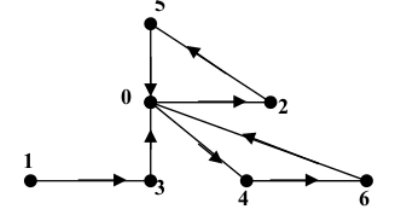
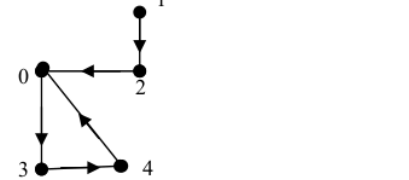
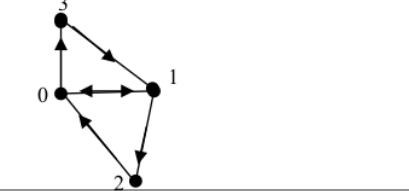
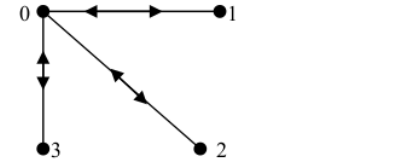
and

$$x_{12} \geq 0; 0 \leq x_{13} \leq 1; x_{14} = 0; x_{21} = 2; x_{23} = 0; x_{24} = 0; 0 \leq x_{31} \leq 1; x_{32} \geq 0; x_{34} = 0; x_{41} = 0; x_{42} = 1; x_{43} = 2; y_{01} = 1; y_{02} = 1; 0 \leq y_{03} \leq 1; 0 \leq y_{04} \leq 1; y_{10} = 0; y_{20} = 0; y_{30} \geq 0; 0 \leq y_{40} \leq 1.$$

$$x_{12}, x_{13}, x_{14}, x_{21}, x_{23}, x_{24}, x_{31}, x_{32}, x_{34}, x_{41}, x_{42}, x_{43} \in \{0, 1, 2\}.$$

$y_{01}, y_{02}, y_{03}, y_{04}, y_{10}, y_{20}, y_{30}, y_{40} \in \{0, 1\}$ . For the rest of Working Area, we conduct the same steps as above, and it is summarized into Table 1 below.

**Table 1. Optimal Route for each Working Area in Sako**

Working Area	Route
I	
II	
III	
IV	
V	
VI	

**Tabel 2. OCVRP Model Before Applying Preprocessing Technique**

WA	Model OCVRP Model Before Applying Preprocessing Technique			Model
	Iteration Number	Variable Number	Cosntraint Number	
I	9	24	7	$Z = 6,5 y_{01} + 2 y_{02} + 6 y_{03} + 8,5 y_{04} + 8,5 x_{12} + 13,5 x_{13} + 15 x_{14} + 8,5 x_{21} + 4 x_{23} + 6,5 x_{24} + 13,5 x_{31} + 4 x_{32} + 2,5 x_{34} + 15 x_{41} + 6,5 x_{42} + 2,5 x_{43}$ Kendala : $x_{12} = 1$ $y_{03} + y_{30} = 1$ $x_{32} = 1$ $y_{04} + y_{40} = 2$ $y_{10} + y_{20} + y_{30} + y_{40} + y_{01} + y_{02} + y_{03} + y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 4,2$ $y_{10} + y_{20} + y_{30} + y_{40} - y_{01} - y_{02} - y_{03} - y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 0$ $y_{10} + y_{20} + y_{30} + y_{40} = 1$
II	6	21	8	$Z = 6,5 y_{01} + 9 y_{02} + 8,5 y_{03} + 9 y_{04} + 15,5 x_{12} + 15 x_{13} + 15,5 x_{14} + 15,5 x_{21} + 0,5 x_{23} + x_{24} + 15 x_{31} + 0,5 x_{32} + 0,5 x_{34} + 15,5 x_{41} + x_{42} + 0,5 x_{43}$ Kendala : $x_{13} + x_{14} = 1$ $y_{02} + y_{20} = 1$ $x_{24} = 1$ $y_{03} + y_{30} = 1$ $y_{04} + y_{40} = 1$ $y_{10} + y_{20} + y_{30} + y_{40} + y_{01} + y_{02} + y_{03} + y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 4,6$ $y_{10} + y_{20} + y_{30} + y_{40} - y_{01} - y_{02} - y_{03} - y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 0$ $y_{10} + y_{20} + y_{30} + y_{40} = 1$
III	6	42	11	$Z = 9 y_{01} + 6 y_{02} + 5,5 y_{03} + 8 y_{04} + 9 y_{05} + 15 y_{06} + 3 x_{12} + 3,5 x_{13} + 6,5 x_{14} + 7,5 x_{15} + 13,5 x_{16} + 3 x_{21} + 0,5 x_{23} + 3 x_{24} + 4 x_{25} + 10,5 x_{26} + 3,5 x_{31} + 0,5 x_{32} + 2,5 x_{34} + 3,5 x_{35} + 10 x_{36} + 6,5 x_{41} + 3 x_{42} + 2,5 x_{43} + x_{45} + 7,5 x_{46} + 7,5 x_{51} + 4 x_{52} + 3,5 x_{53} + x_{54} + 6,5 x_{56} + 13,5 x_{61} + 10,5 x_{62} + 10 x_{63} + 7,5 x_{64} + 6,5 x_{65}$ Kendala : $y_{02} + y_{20} = 1$ $x_{25} = 1$ $y_{03} + y_{30} = 1$ $x_{31} = 1$ $y_{04} + y_{40} = 1$ $x_{46} = 1$ $y_{05} + y_{50} = 1$ $y_{60} = 1$ $y_{10} + y_{20} + y_{30} + y_{40} + y_{01} + y_{02} + y_{03} + y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 6,73$ $y_{10} + y_{20} + y_{30} + y_{40} - y_{01} - y_{02} - y_{03} - y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 0$ $y_{01} + y_{02} + y_{03} + y_{04} + y_{05} + y_{06} = 1$
IV	6	20	8	$Z = 2 y_{01} + 8 y_{02} + 10 y_{03} + 11 y_{04} + 9 x_{12} + 11 x_{13} + 12 x_{14} + 9 x_{21} + 2 x_{23} + 3 x_{24} + 11 x_{31} + 2 x_{32} + x_{34} + 12 x_{41} + 3 x_{42} + x_{43}$ Kendala : $x_{12} + x_{13} = 1$ $y_{02} + y_{20} = 1$ $y_{03} + y_{30} = 1$ $y_{04} + y_{40} = 1$ $x_{43} = 1$ $y_{10} + y_{20} + y_{30} + y_{40} + y_{01} + y_{02} + y_{03} + y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 4,2$ $y_{10} + y_{20} + y_{30} + y_{40} - y_{01} - y_{02} - y_{03} - y_{04} + x_{12} + x_{13} + x_{14} + x_{21} + x_{23} + x_{24} + x_{31} + x_{32} + x_{34} + x_{41} + x_{42} + x_{43} \geq 0$ $y_{10} + y_{20} + y_{30} + y_{40} = 1$
V	3	12	6	$Z = 1,6 x_{01} + 2 x_{02} + 3 x_{03} + 11 x_{04} + 1,6 x_{10} + x_{12} + 2 x_{13} + 2 x_{20} + x_{21} + x_{23} + 3 x_{30} + 2 x_{31} + x_{32}$ Kendala : $x_{01} + x_{02} + x_{03} = 2$ $x_{12} + x_{13} = 1$ $x_{20} + x_{21} + x_{23} = 1$ $x_{30} + x_{31} = 2$ $x_{01} + x_{02} + x_{03} + x_{04} + x_{10} + x_{12} + x_{13} + x_{20} + x_{21} + x_{23} + x_{30} + x_{31} + x_{32} \geq 0$

**Tabel 3. OCVRP Model After Applying Preprocessing Technique**

WA	Model OCVRP Model After Applying Preprocessing Technique			Model
	Iteration Number	Variable number	Constraint Number	
I	4	4	6	$Z = 6,5y_{01} + 2y_{02} + 6y_{03} + 8,5y_{04} + 8,5x_{12} + 15x_{14} + 8,5x_{21} + 4x_{23} + 6,5x_{24} + 4x_{32} + 2,5x_{34} + 15x_{41} + 6,5x_{42} + 2,5x_{43}$ Kendala : $x_{12} = 1$ $y_{03} + y_{30} = 1$ $x_{32} = 1$ $y_{04} + y_{40} = 2$ $y_{10} + y_{20} + y_{30} + y_{40} = 1$
II	2	5	6	$Z = 6,5y_{01} + 9y_{02} + 8,5y_{03} + 9y_{04} + 15x_{13} + 15,5x_{14} + 0,5x_{23} + x_{24} + 15x_{31} + 0,5x_{32} + 0,5x_{34} + 15,5x_{41} + x_{42} + 0,5x_{43}$ Kendala : $x_{13} + x_{14} = 1$ $y_{02} + y_{20} = 1$ $x_{24} = 1$ $y_{03} + y_{30} = 1$ $y_{04} + y_{40} = 1$ $y_{10} + y_{20} + y_{30} + y_{40} = 1$
III	4	8	9	$Z = 9y_{01} + 8y_{04} + 9y_{05} + 15y_{06} + 3x_{12} + 3,5x_{13} + 6,5x_{14} + 7,5x_{15} + 13,5x_{16} + 3x_{21} + 0,5x_{23} + 3x_{24} + 4x_{25} + 10,5x_{26} + 3,5x_{31} + 0,5x_{32} + 2,5x_{34} + 3,5x_{35} + 10x_{36} + 6,5x_{41} + 3x_{42} + 2,5x_{43} + x_{45} + 7,5x_{46} + 7,5x_{51} + 4x_{52} + 3,5x_{53} + x_{54} + 6,5x_{56} + 13,5x_{61} + 10,5x_{62} + 10x_{63} + 7,5x_{64} + 6,5x_{65}$ Kendala : $y_{02} + y_{20} = 1$ $x_{25} = 1$ $y_{03} + y_{30} = 1$ $x_{31} = 1$ $y_{04} + y_{40} = 1$ $x_{46} = 1$ $y_{05} + y_{30} = 1$ $y_{60} = 1$ $y_{01} + y_{02} + y_{03} + y_{04} + y_{05} + y_{06} = 1$
IV	2	6	6	$Z = 2y_{01} + 8y_{02} + 10y_{03} + 11y_{04} + 9x_{12} + 11x_{13} + 9x_{21} + 2x_{23} + 3x_{24} + 11x_{31} + 2x_{32} + x_{34} + 3x_{42} + x_{43}$ Kendala : $x_{12} + x_{13} = 1$ $y_{02} + y_{20} = 1$ $y_{03} + y_{30} = 1$ $y_{04} + y_{40} = 1$ $x_{43} = 1$ $y_{10} + y_{20} + y_{30} + y_{40} = 1$
V	2	5	5	$Z = 1,6x_{01} + 2x_{02} + 3x_{03} + 11x_{04} + 1,6x_{10} + 2x_{13} + 2x_{20} + x_{23} + 3x_{30} + 2x_{31} + x_{32}$ Kendala : $x_{01} + x_{02} + x_{03} = 2$ $x_{13} = 1$ $x_{20} + x_{23} = 1$ $x_{30} + x_{31} = 2$

Table 2 and Table 3 explain that OCVRP model by applying preprocessing technique will yield simpler OCVRP model compared to model by not applying that technique by showing the reduction in number of iteration and reduction in number of constraints.

Figure 1 below shows us the comparison between OCVRP model before and after applying the preprocessing and probing technique. We can see that the number of iteration, variable and constraint reduce significantly after applying the preprocessing technique. For example, in term of number of variable, we have tremendous reduction in number of variables after applying the preprocessing and probing technique.

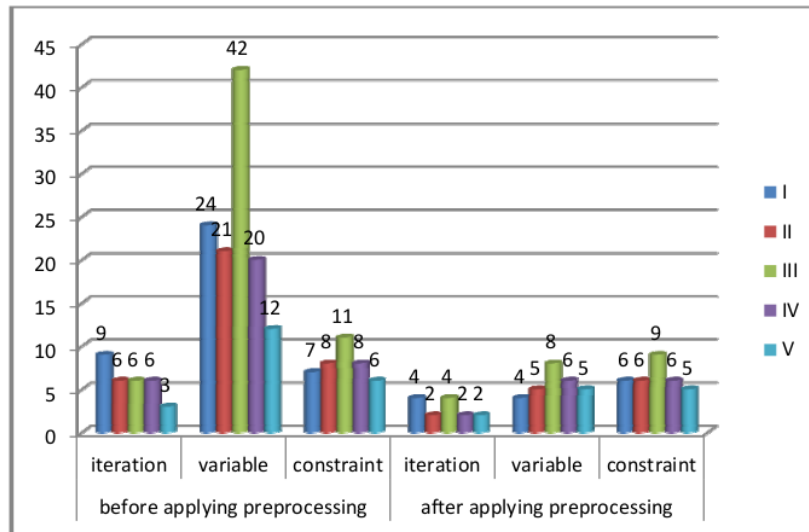


Figure 1. Comparison of Number of Iterations, Variables and Constraints Before and After Applying Preprocessing and Probing Techniques

#### 4. CONCLUSION

We can conclude that by applying preprocessing technique in the problem of transporting the rubbish, the simpler OCVRP model can be obtained, the faster optimal solution can be achieved compared to not applying the preprocessing technique. In addition, by applying the preprocessing technique, the number of iteration and constraint is also reduced.

#### ACKNOWLEDGEMENTS

This research was partially supported by Hibah Bersaing Grant of Directorate General of Higher Education of Indonesia (DIKTI) year 2011. The authors would also like to thank to the editor and referees for their valuable comments and suggestion.

#### REFERENCES

- [1] Hitchford, A.N., J. Lygaard., and R.W. Eglese. *A branch and cut algorithm for capacitated open vehicle routing problem*, 2006. [cited 2009 11 July]; Available from: <http://www.lancs.ac.uk/staff/lethfoa/articles/ovrp/pdf>.
- [2] Savelsbergh, M.W.P. "Preprocessing and probing techniques for mixed integer programming problems", *ORSA J. on Computing*, Vol. 6. Pp. 445-454, 1994.
- [3] Nemhauser, G.L. and L.A. Wolsey, *Integer and Combinatorial Optimization*, Canada: John Wiley & Sons, Inc, 1999.
- [4] Irmeilyana, et al. "Analisis Penentuan Model SCVRP untuk Menentukan Rute Optimal Transportasi Pengangkutan Sampah di Kota Palembang", *Laporan Penelitian Hibah Penelitian PHK A2 Jurusan Matematika FMIPA Unsri*. 2007.
- [5] Sari, Y.M., Indrawati, and Irmeilyana. "Penerapan Model Open Capacitated Vehicle Routing Problem (OCVRP) dalam Mencari Rute Minimum Transportasi Pengangkutan Sampah di Kecamatan Sako Kota Palembang, in Jurusan Matematika", *Skripsi SI*, Jurusan Matematika FMIPA Universitas Sriwijaya: Indralaya, 2009.
- [6] Nuratika, Indrawati, and Irmeilyana. "Penentuan Rute Minimum Open Capacitated Vehicle Routing Problem (OCVRP) pada Masalah Transportasi Sampah di Kota Palembang, in Jurusan Matematika FMIPA, *Skripsi SI*, Universitas Sriwijaya, 2009.
- [7] Irmeilyana, F.M. Puspita, and Indrawati. "The determination of optimal route of open capacitated vehicle routing problem (OCVRP) on garbage transportation model in Kecamatan Seberang Ulu II Kota Palembang", in *Proceeding of International Conference on Applied Analysis and Algebra (ICAAA) 2011*. Yildiz University, Istanbul, 2011.
- [8] Irmeilyana, et al. "Modeling and Optimal Solution of Open Capacitated Vehicle Routing Problem (Ocvrp) in Garbage Transportation in Kecamatan Seberang Ulu I Kota Palembang", *Australian Journal of Basic and Applied Sciences*, Vol/Issue: 5(5). Pp. 9-17, 2011.

*The Preprocessing and Probing Technique of Open Capacitated Vehicle Routing Problem (Irmeilyana)*



- [9] Irmeilyana, et al. Preprocessing techniques in SCVR<sup>1</sup> model: case of rubbish transportation problem in Kecamatan Iilir Barat II Palembang South Sumatera Indonesia”, *International Journal of Advances in Applied Sciences(IJAAS)*, Vol/Issue: **I**(3). Pp. 108-115, 2012.

#### BIOGRAPHIES OF AUTHORS



Irmeilyana received her S.Si (Undergraduate Degree in Science) in Mathematics from Bogor Agriculture Institute (IPB) Indonesia in 1997. Then she received her Master Degree in Mathematics from Bandung Technology Institut<sup>6</sup> (ITB) Indonesia in 1999. She has been a Mathematics Department member at Faculty Mathematics and Natural Sciences Sriwijaya University South Sumatera Indonesia. Her research interests include Statistics, optimization and its applications.



Fitri Maya Puspita received her B.S. degree in Mathematics from Sriwijaya University, South Sumatera, Indonesia in 1997. Then she received her M.Sc in Mathematics from Curtin University of Technology (CUT) Western Australia in 2004. She is currently PhD candidate of Faculty of Science and Technology Islamic Science University of Malaysia (USIM), Nilai, Negeri <sup>6</sup>mbilan Darul Khusus, Malaysia. She has been a Mathematics Department member at Faculty mathematics and Natural Sciences Sriwijaya University South Sumatera Indonesia since 1998. Her research interests include optimization and its applications such as vehicle routing problems and QoS pricing and charging in third generation internet.



Indrawati received her received her B.S. degree in Mathematics from Sriwijaya University, South Sumatera, Indonesia in 1996. Then she received M.Si in Mathematics Actuarial from Bandung Institute of <sup>6</sup>chnology, Indonesia in 2004. She has been a Mathematics Department member at Faculty mathematics and Natural Sciences Sriwijaya University South Sumatera Indonesia since 1998. Her research interest includes actuarial science and its applications in insurance and risk theory.



Fitra Nur Azizah received her B.S. degree in Mathematics from Sriwijaya University, South Sumatera, Indonesia in 2011. Her research interest includes Optimization, Graph Theory and its applications.

# 39-2013-The preprocessing-IJAAS

## ORIGINALITY REPORT

9%

SIMILARITY INDEX

6%

INTERNET SOURCES

6%

PUBLICATIONS

5%

STUDENT PAPERS

## PRIMARY SOURCES

1	pdffox.com Internet Source	1%
2	journaldatabase.info Internet Source	1%
3	Deza, Monica. "THE EFFECTS OF ALCOHOL ON THE CONSUMPTION OF HARD DRUGS: REGRESSION DISCONTINUITY EVIDENCE FROM THE NATIONAL LONGITUDINAL STUDY OF YOUTH, 1997 : THE EFFECTS OF ALCOHOL ON THE CONSUMPTION OF HARD DRUGS", Health Economics, 2014. Publication	1%
4	Submitted to Politeknik Negeri Sriwijaya Student Paper	1%
5	ijiepr.iust.ac.ir Internet Source	1%
6	Robinson Sitepu, Fitri Maya Puspita, Shintya Apriliyani. "Utility function based-mixed integer nonlinear programming (MINLP) problem model of information service pricing	1%

# schemes", 2017 International Conference on Data and Software Engineering (ICoDSE), 2017

Publication

---

7	Submitted to Universidad Carlos III de Madrid Student Paper	1 %
8	Submitted to Ambedkar University Delhi Student Paper	1 %
9	<a href="http://uk.mathworks.com">uk.mathworks.com</a> Internet Source	1 %
10	S Sahirman, Ardiansyah, M Rifan, E Melmambessy. "Transportation model and techno economic as useful tools in agroindustry clustering: a case study in district Semangga, Merauke", IOP Conference Series: Earth and Environmental Science, 2019 Publication	1 %
11	<a href="http://media.neliti.com">media.neliti.com</a> Internet Source	1 %

---

Exclude quotes Off

Exclude matches < 1%

Exclude bibliography Off