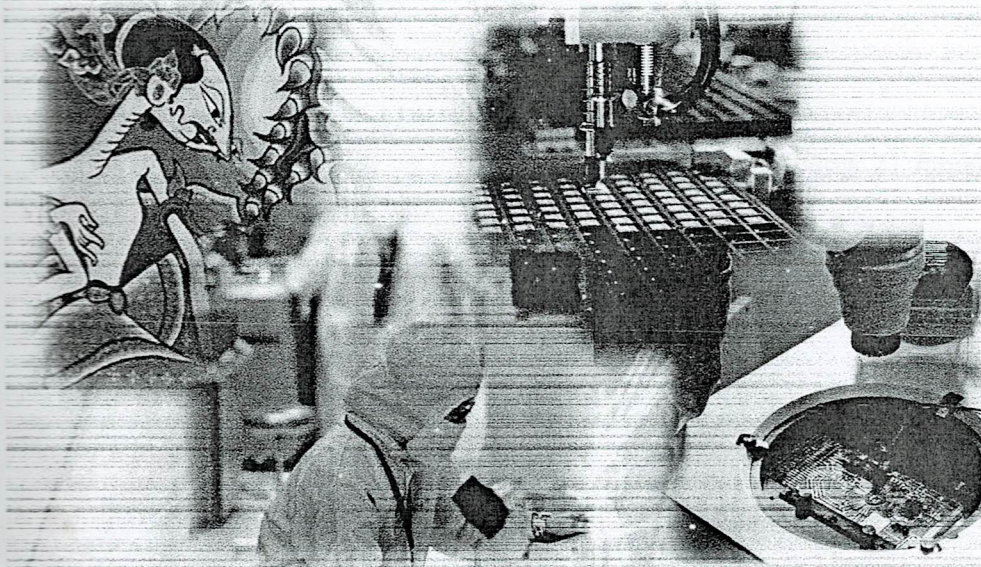


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ASIA PACIFIC CONFERENCE On ART, SCIENCE, ENGINEERING & TECHNOLOGY
(ASPAC On ASET) LETTER OF TRANSMITTAL

Solo, 22 May 2008

Dear Sir,

We have the honor to transmit herewith the Report of the ASPAC On ASET held in Solo-Indonesia, from 19 to 22 of May, 2008.

Accept, Sir, the assurance of our highest consideration.

Prof. Dr. Ir. R.J. Widodo, M.Sc
MASDALI-Bandung

**WELCOMING MESSAGE FROM
THE CHAIRMAN OF THE NATIONAL STEERING COMMITTEE
FOR
THE ASIA PACIFIC CONFERENCE (ASPAC) On
ART, SCIENCE, ENGINEERING & TECHNOLOGY (ASET) 2008
Rohani Jahja Widodo**

at
The Universitas Sebelas Maret, The Institut Seni Indonesia Surakarta
&
The Universitas Muhammadiyah Surakarta
in
Surakarta
May 19 – 22, 2008

Ladies and Gentlemen,

As the Chairman of the NSC for the ASPAC on ASET 2008, I would like to warmly welcome the presence the Mayor of Kota Surakarta, Rector of the Universitas Sebelas Maret, the Rector of the Institut Seni Indonesia, the Rector of the Universitas Muhammadiyah Surakarta, the Rector of Universitas Negeri Yogyakarta, the Rector of Universitas Sanata Dharma Yogyakarta and the Rector of Universitas Negeri Surabaya.

The first ASPAC on ASET was held in 04-08 October 2004 in Bandung by MASDALI in collaboration with Indonesian Institute of Sciences, the Universitas Kristen Maranatha and the Universitas Katolik Parahyangan the proceeding with ISBN 979-3688-04-1.

I would like to express my sincere appreciation to:

- | | |
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| 1. Kota Surakarta. | 11 Universitas Kriten Satya Wacana, |
| 2. Universitas Sebelas Maret, | 12 Universitas Negeri Lampung, |
| 3. Institut Seni Indonesia, | 13. Universitas Negeri Yogyakarta, |
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for their scientific and financial sponsors.

Ladies and Gentlemen

The theme of this conference is

**“IMPROVEMENT of COMPETANCE
of
the HUMAN RESOURCES
through**

EDUCATION, TRAINING, RESEARCH & DEVELOPMENT”

It is indeed a distinct privilege and an honor for me to be given this opportunity to chair this conference.

I would like to extend a hearty appreciation to all speakers, participants, and sponsors, because of your participation at ASPAC on ASET 2008 is a strong indication of your deep interest and concern to the problem we are facing at present in Asia Pacific Region :

The QUALITY of the HUMAN RESOURCES..

I would like to thank to the MASDALI (Indonesian Control Systems Society), which allow me to chair this conference. MASDALI is proud and honored to host this ASPAC on ASET 2008 in Surakarta city of Bengawan Solo and the first PON was held in 1952. There are many activities during the conference :

1. Plenary Sessions (Policy Papers),
2. Parallel Sessions (Technical Papers in the field of A.S.E.T),
3. Science & Technology Exhibition,
4. Scientific Meeting to explore the scientific collaborations, among Lectures, Trainers, Researchers and Developers in the Asia Pacific Region.
- and
5. Scientific Tours.

In closing, I would like to express my gratitude to the participants especially those from overseas in taking the time attending this conference.

BILA ADA JARUM YANG PATAH JANGANLAH DISIMPAN DALAM PETI ;

BILA ADA KATA DAN LANGKAH YANG SALAH JANGANLAH DISIMPAN DALAM HATI

Mohon maaf atas kekurangan dan kesalahan kami.

We wish you a rewarding and enjoyable stay in Surakarta, Indonesia.

Thank you,

Rahani Jahja Widodo

The Chairman of the NSC for ASPAC on ASET 2008

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THE ESTIMATION OF GRAVITY MODEL COMBINED WITH THE MULTI-NOMIAL-LOGIT MODEL BASED ON TRAFFIC VOLUMES

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Abstract: Many problems in transportation require an Origin-Destination (O-D) matrix which is usually obtained from a large survey. This survey tends to be costly. Therefore, more use should be made of low-cost traffic data. This research aims to enhance the accuracy of the doubly constrained gravity model using negative exponential as deterrence function by applying transport demand models, described as a function of one or more parameters. The estimation methods have been developed, namely: Non-Linear-Least-Squares (NLLS) will be used as methods to estimate the parameters of transport demand models. The work concentrated on the estimation of **Gravity (GR)** model combined with the **Multi-Nomial-Logit (MNL)** model. General conclusions regarding the advantageous of the approach are given at the end of the paper.

BACKGROUND

The development of techniques for calibrating the trip distribution models from traffic volumes to obtain the O-D matrices is well advanced (see **Tamin, 1988**, see also **Figure 1**). **Figure 1** shows the roadmap of the Transport Demand Model Estimation Research Agenda which have been conduct since 1988 by the Division of Transportation Engineering. Therefore, positive results on this development will be further developed by combining trip distribution and mode choice model (TDMC) and calibrating it using low cost traffic (passenger) volumes information (see **Tamin and Purwanti, 2002**). In this case, the TDMC model is represented by a function of a model form and relevant parameters.

The idea of combining 'traditional' data sources (home or roadside interviews) with low cost data like traffic counts is not entirely new (see **Tamin, 1988**, see also **Figure 1**). The models can be used to combine, for example, roadside interview data with traffic (passenger) counts and this can be achieved with or without an explicit travel demand model (trip distribution model). For the purpose of public transport demand estimation, this idea can be extended to the development of a practical estimation approach to calibrate the combined **Trip Distribution and Mode Choice (TDMC)** model with traffic (passenger) counts and other simple zonal planning data.

This approach assumes that either trip distribution or mode choice model is represented by certain model forms. As usual, the traffic (passenger) counts are expressed as a function of the TDMC model. In this case, the TDMC model is represented by a function of a model form and relevant parameters. The parameters of the postulated model are then estimated, so that the errors between the estimated and observed traffic (passenger) counts are minimised.

OBJECTIVES

The level of accuracy of the estimated O-D matrices depends on some following factors:

- a. the transport demand model itself in representing the trip making behaviour within the study area;
- b. the estimation method used to calibrate the model from traffic counts;
- c. trip assignment techniques used in determining the routes taken through the network;
- d. location and number of traffic counts;
- e. errors in traffic count information;
- f. finally, the level of resolution of the zoning system and the network definition.

Route Choice is a major element which has to be considered carefully by travellers as an attempt to minimize their travel time. The main objective of the route choice model is to predict the correct throughput of traffic on each road (flow distribution). The previous research still in a burden condition of "All or Nothing" which was assumption that driver who select a route try to minimize its expense, not depend on traffic flow level, so all driver will select the same route.

This method is not realistic for some congested road network in urban area because it never consider to the traffic jam effect and various of perception in considering of route selection.

However, the previous research still in a burden condition of "All or Nothing" which is not realistic for some congested road networks in urban area. So, the main objective of this research is the application of a combined trip distribution-mode choice model estimated from traffic count under equilibrium condition (congested road network).

Referring to the previous research, the main objective of the research development is develop and demonstrate the application of a combined trip distribution-mode choice model estimated from traffic count under equilibrium condition.

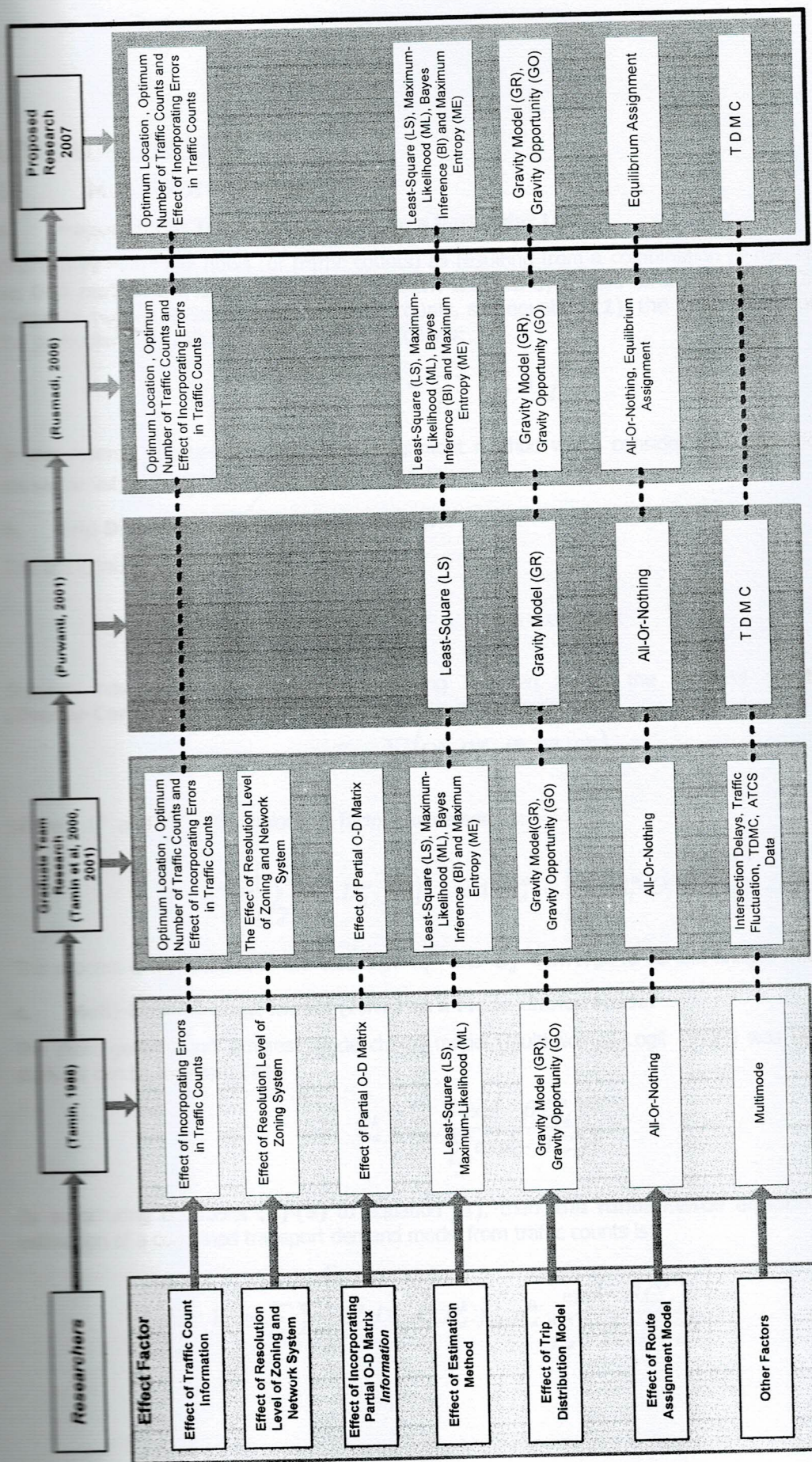


Figure 1 Roadmap On Transport Demand Model Estimation Research Agenda

LITERATURE REVIEW

1. Model Formulation

a. Proportion of Trip Interchanges on a Particular Link

One can interpret link flows (or traffic counts) as resulting from a combination of two elements: an **O-D matrix** and the **route choice** pattern selected by drivers on the network. These two elements may be linearly related to traffic counts, see equation (1), the total volume of flow in the particular link l (V_l) can be expressed as follows:

$$V_l = \sum_i \sum_d T_{id} \cdot p_{id}^l \quad (1)$$

In this research, the use of equilibrium assignment method which consider the congestion effect cause the value of p_{id}^l obtained is between 0-1.

b. Trip Distribution-Mode Choice Model

The analogous transport gravity model is:

$$T_{id} = k \frac{O_i O_d}{d_{id}^2} \quad : \quad k \text{ is a constant} \quad (2)$$

Suppose now there are **M** modes travelling between zones, the modified gravity model (**Doubly-Constrained Gravity Model**) can then be expressed as:

$$T_{id} = \sum_m (O_i^m \cdot D_d^m \cdot A_i^m \cdot B_d^m \cdot f_{id}^m) \quad (3)$$

where: A_i^m and B_d^m = the balancing factors expressed as:

$$A_i^m = \left[\sum_d (B_d^m \cdot D_d^m \cdot f_{id}^m) \right]^{-1} \quad \text{and} \quad B_d^m = \left[\sum_i (A_i^m \cdot O_i^m \cdot f_{id}^m) \right]^{-1} \quad (4)$$

This process is repeated until the values of A_i^m and B_d^m converge to certain unique values.

c. Multi-Nomial-Logit model (MNL) as a Mode Choice Model

The most general and simplest mode choice model (Multi-Nomial Logit Model) was used in this study. It can be expressed as:

$$T_{id}^k = T_{id} \cdot \frac{\exp(-\beta \cdot C_{id}^k)}{\sum_m \exp(-\beta \cdot C_{id}^m)} \quad (5)$$

By substituting equations (2)-(5) to equation (1), then 'the fundamental equation' for the estimation of a combined transport demand model from traffic counts is:

$$V_l^k = \sum_d \sum_i \left[O_i^k \cdot D_d^k \cdot A_i^k \cdot B_d^k \cdot f_{id}^k \cdot p_{id}^{lk} \frac{\exp(-\beta \cdot C_{id}^k)}{\sum_m \exp(-\beta \cdot C_{id}^m)} \right] \quad (6)$$

Equation (6) is a system of L simultaneous equations with only one (1) unknown parameter (β) need to be estimated.

2. Estimation Methods

There are four estimation methods to estimate the unknown parameter so that the model reproduces the estimated traffic (passenger) counts as close as possible to the observed ones (see Tamin, 2000).

- Least-Squares estimation method (LLS or NLLS)
- Maximum-Likelihood estimation method (ML)
- Bayes-Inference estimation method (BI)
- Maximum-Entropy estimation method (ME)

1. Non-Linear-Least-Squares Estimation Method (NLLS)

The main idea of this method is to estimate the unknown parameter which minimises the sum of the squared differences between the estimated and observed traffic counts. The problem now is:

$$\text{to minimise } S = \sum_l [V_l^{+k} - V_l^k]^2 \quad (7)$$

$\hat{V}_l^k$ = observed traffic flows for mode k
 l

V_l^k = estimated traffic flows for mode

Having substituted (6) to (7), the following set of equation is required in order to find a set of unknown parameter β which minimises eq. (8):

$$\frac{\partial S}{\partial \beta} = \sum_l \left[\left(2 \sum_i \sum_d T_{id}^k \cdot p_{id}^{lk} - V_l^k \right) \left(\frac{\sum_i \sum_d \delta T_{id}^k}{\delta \beta \cdot p_{id}^{lk}} \right) \right] = 0 \quad (8)$$

Equation (8) is an equation which has only one (1) unknown parameter β need to be estimated. Then it is possible to determine uniquely all the parameters, provided that $L > 1$. Newton-Raphson's method combined with the Gauss-Jordan Matrix Elimination technique can then be used to solve equation (8).

2. Maximum-Likelihood Estimation Method (ML)

Tamin (1988, 2000) have also developed an estimation method which tries to maximise the probability as expressed in equation (9).

$$\text{to maximize } L = c \cdot \prod_l p_l^{\hat{V}_l^k} \quad (9)$$

$$\text{subject to: } \sum_l V_l^k - \hat{V}_T^k = 0 \quad (10)$$

The main idea of this method is to estimate the unknown parameter which maximise L .

$$\text{Max } L_1 = \sum_l \left[\hat{V}_l^k \cdot \log_e \left(\sum_i \sum_d T_{id}^k \cdot p_{id}^{lk} \right) - \theta \cdot \sum_i \sum_d T_{id}^k \cdot p_{id}^{lk} \right] + \theta \cdot \hat{V}_T^k - \hat{V}_T^k \cdot \log_e \hat{V}_T^k + \log_e c \quad (11)$$

$$\frac{\delta L_1}{\delta \beta} = f\beta = \sum_l \left[V_l^m \frac{\sum_i \sum_d \frac{\delta T_{id}^m}{\delta \beta \cdot p_{id}^{lm}}}{\sum_i \sum_d T_{id}^m \cdot p_{id}^{lm}} \right] - \theta \cdot \sum_i \sum_d \frac{\delta T_{id}^m \cdot p_{id}^{lm}}{\delta \beta \cdot p_{id}^{lm}} = 0 \quad (12a)$$

$$\frac{\delta L_1}{\delta \theta} = f\theta = -\theta \left[\sum_i \sum_d T_{id}^m \cdot p_{id}^{lm} - V_T^m \right] = 0 \quad (12b)$$

Equation (12ab) is in effect a system of 2 (two) simultaneous equations which has 2 (two) parameters β and θ need to be estimated. Again, the Newton's method combined with the Gauss-Jordan Matrix Elimination technique can then be used to solve for equation (12ab).

3. Bayes-Inference Estimation Method (BI)

The objective function of the Bayes-Inference (BI) estimation method can be expressed as:

$$\text{to maximize BI} = \sum_l \left[\hat{V}_l^k \cdot \log_e \left(\sum_i \sum_d T_{id}^k \cdot p_{id}^{lk} \right) \right] \quad (13)$$

In order to determine uniquely parameter β of the Gravity (GR) model, which maximizes equation (13), the following two sets of equations are then required. They are as follows:

$$\frac{\partial \text{BI}}{\partial \beta} = \sum_l \left[\left(\frac{\hat{V}_l^k}{\sum_i \sum_d (T_{id}^k \cdot p_{id}^{lk})} \right) \cdot \left(\sum_i \sum_d \left(\frac{\partial T_{id}^k}{\partial \beta} \cdot p_{id}^{lk} \right) \right) \right] = 0 \quad (14)$$

Equation (14) is an equation which has one (1) unknown parameter β need to be estimated. The Newton's method combined with the Gauss-Jordan Matrix Elimination technique can then be used to solve for equation (14).

4. Maximum-Entropy Estimation Method (ME)

Mathematically, the objective function of the ME estimation method can be expressed as:

$$\text{to maximise } E_1 = -\sum_{l=1}^L \left[\sum_{i=1}^N \sum_{d=1}^N T_{id} \cdot p_{id}^l \cdot \log_e \left(\frac{\sum_{i=1}^N \sum_{d=1}^N T_{id} \cdot p_{id}^l}{\hat{V}_l} \right) - \left(\sum_{i=1}^N \sum_{d=1}^N T_{id} \cdot p_{id}^l \right) + \hat{V}_l \right] \quad (15)$$

In order to determine uniquely parameter β of the GR model which maximizes the equation (15), the following equation is then required. They are as follows:

$$\frac{\partial E_1}{\partial \beta} = -\sum_l \left[\left(\sum_i \sum_d \frac{\partial T_{id}^k}{\partial \beta} \cdot p_{id}^{lk} \right) \cdot \log_e \left(\frac{\sum_i \sum_d T_{id}^k \cdot p_{id}^{lk}}{\hat{V}_l^k} \right) \right] = 0 \quad (16)$$

Equation (16) is an equation which has only one (1) unknown parameter β need to be estimated. Newton-Raphson's method combined with the Gauss-Jordan Matrix Elimination technique can then be used to solve equation (16).

METHODOLOGY

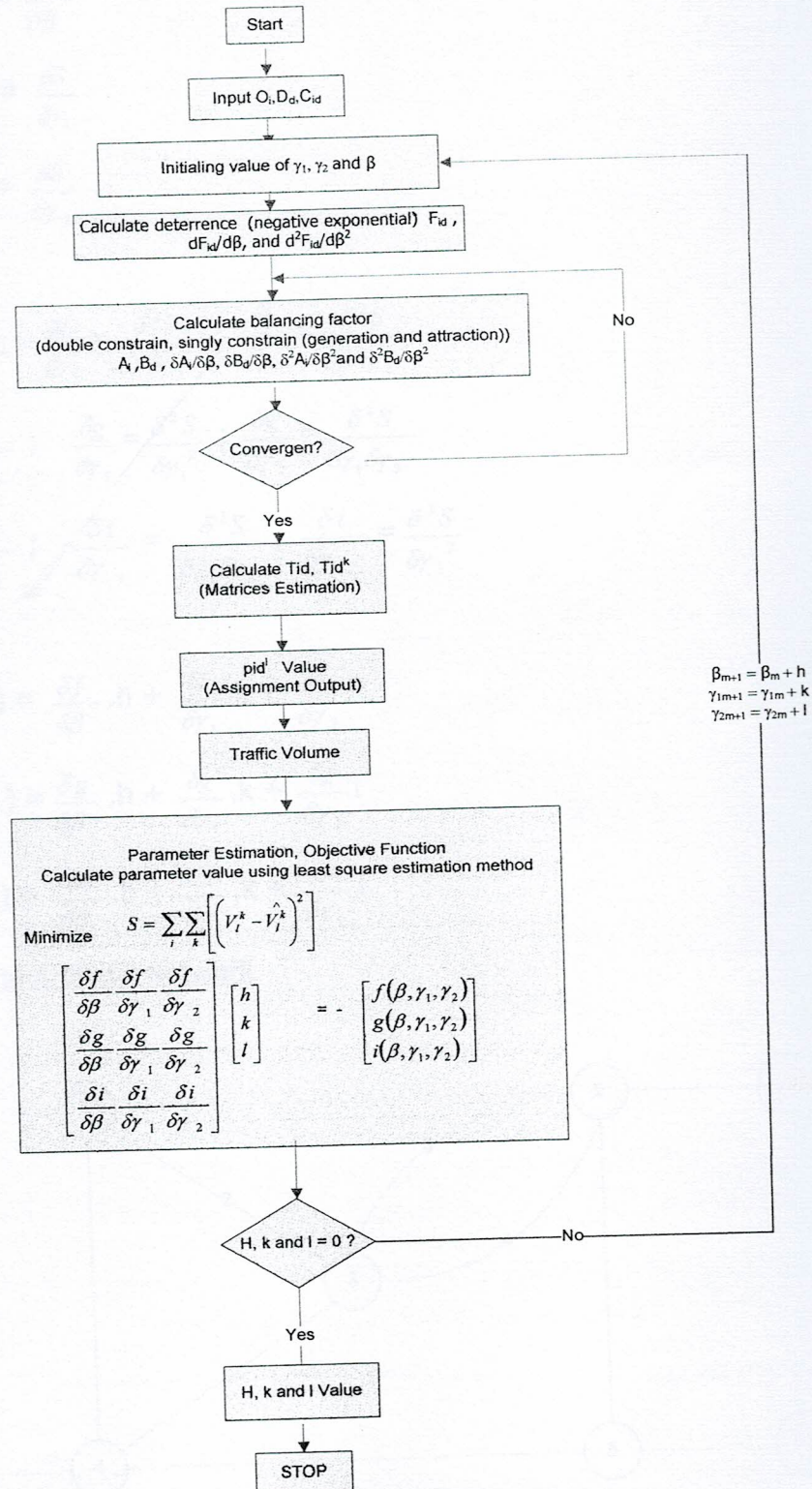


Figure 2 Research Methodology

$$f(\beta, \gamma_1, \gamma_2) = \frac{\delta S}{\delta \beta}$$

$$g(\beta, \gamma_1, \gamma_2) = \frac{\delta S}{\delta \gamma_1}$$

$$i(\beta, \gamma_1, \gamma_2) = \frac{\delta S}{\delta \gamma_2}$$

$$\frac{\delta f}{\delta \beta} = \frac{\delta^2 S}{\delta \beta^2}; \quad \frac{\delta f}{\delta \gamma_1} = \frac{\delta^2 S}{\delta \beta \delta \gamma_1}; \quad \frac{\delta f}{\delta \gamma_2} = \frac{\delta^2 S}{\delta \beta \delta \gamma_2}$$

$$\frac{\delta g}{\delta \beta} = \frac{\delta^2 S}{\delta \beta \delta \gamma_1}; \quad \frac{\delta g}{\delta \gamma_1} = \frac{\delta^2 S}{\delta \gamma_1^2}; \quad \frac{\delta g}{\delta \gamma_2} = \frac{\delta^2 S}{\delta \gamma_1 \delta \gamma_2}$$

$$\frac{\delta i}{\delta \beta} = \frac{\delta^2 S}{\delta \beta \delta \gamma_2}; \quad \frac{\delta i}{\delta \gamma_1} = \frac{\delta^2 S}{\delta \gamma_1 \delta \gamma_2}; \quad \frac{\delta i}{\delta \gamma_2} = \frac{\delta^2 S}{\delta \gamma_2^2}$$

$$f(\beta, \gamma_1, \gamma_2) = \frac{\delta f}{\delta \beta} .h + \frac{\delta f}{\delta \gamma_1} .k + \frac{\delta f}{\delta \gamma_2} .i$$

$$g(\beta, \gamma_1, \gamma_2) = \frac{\delta g}{\delta \beta} .h + \frac{\delta g}{\delta \gamma_1} .k + \frac{\delta g}{\delta \gamma_2} .i$$

$$i(\beta, \gamma_1, \gamma_2) = \frac{\delta i}{\delta \beta} .h + \frac{\delta i}{\delta \gamma_1} .k + \frac{\delta i}{\delta \gamma_2} .i$$

Application in Artificial Network

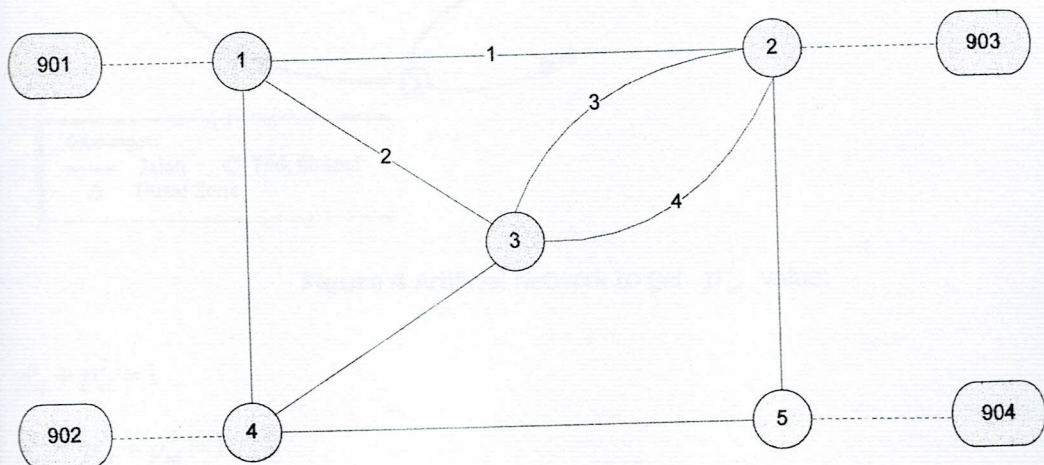


Figure 3 Artificial Network

1. Matrices C_{id}^1

From/to	1	2	3	4
1	15	20	30	60
2	35	15	50	55
3	60	45	20	45
4	35	50	45	15

2. Matrices C_{id}^2

From/to	1	2	3	4
1	5	10	20	50
2	25	5	40	45
3	50	35	10	35
4	25	40	35	5

3. Matrices C_{id}

Assumption to get C_{id} value

$$C_{id} = \frac{(C_{id}^1 + C_{id}^2)}{2}$$

From/to	1	2	3	4
1	10	15	25	55
2	30	10	45	50
3	55	40	15	40
4	30	45	40	10

Simplification process to get p_{id}^l value:

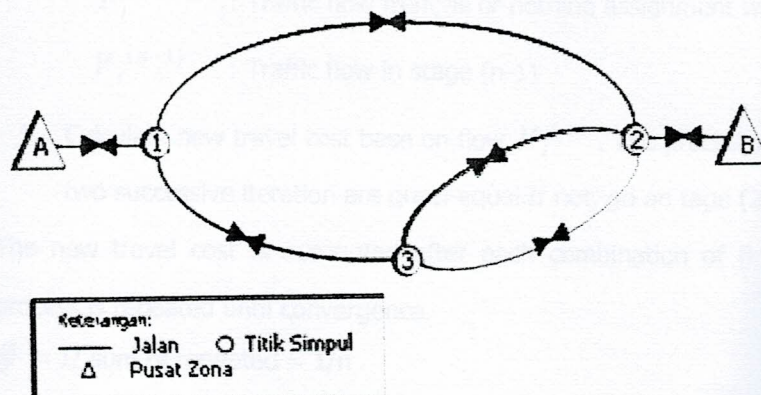


Figure 4 Artificial Network to get p_{id}^l value:

$$p_{id}^1 + p_{id}^2 = 1$$

$$p_{id}^1 + p_{id}^3 + p_{id}^4 = 1$$

$$T_{12} = 810$$

Cost Function in each route is:

$$\text{Route 1 : } C_{12} + 0.005 V_1$$

$$\text{Route 2 : } C_{12} + 0.02 V_2$$

$$\text{Route 3 : } C_{12} + 0.015 V_3$$

Using Repeated Assignment Method, Origin Destination Matrices is assigned in network system continuously. Start with an all or nothing assignment, and then follow the rule developed by Frank-Wolfe to iterate toward the minimum value of the objective function. The new traffic volume is accounted as linear combination between V_n and $V_{(n-1)}$ in each assignment procedure.

This algorithm as below:

1. Choice 1 set cost data
2. Build 1 set minimum cost, set $n=n+1$
3. Assign Origin Destination Matrices using all or nothing assignment to get Flow (F_i) value
4. Calculate volume existing

$$V_i^{(n)} = (1 - \phi) \cdot V_i^{(n-1)} + \phi \cdot F_i$$

ϕ : Parameter (with value = 0-1)

$V_i^{(n)}$: Traffic flow in stage n

F_i : Traffic flow from all or nothing assignment with travel cost from stage (n-1)

$V_i^{(n-1)}$: Traffic flow in stage (n-1)

5. Calculate new travel cost base on flow $V_i^{(n)}$. The procedure is stopped when the flow for two successive iteration are quasi-equal. If not, go on stage (2).

The new travel cost is accounted after each combination of flow ($V_i^{(n)}$) is assigned. The process is repeated until convergence.

$$\phi = 1 / \text{sum of repeated} = 1/n$$

Next, for real network system, p_{id}^1 value is expected as output of assignment from EMME/2 software programs. The implementation in software can see on this figure, using C++ as below:


```

C:\WINDOWS\system32\cmd.exe
Masukkan Jumlah Zona: 4
Masukkan Nilai Beta: 0.06

Matrik Cidk (Moda 1)
15.00000 20.00000 30.00000 60.00000
35.00000 15.00000 50.00000 55.00000
60.00000 45.00000 20.00000 45.00000
35.00000 50.00000 45.00000 15.00000

Matrik Cidm (Moda 2)
5.00000 10.00000 20.00000 50.00000
25.00000 5.00000 40.00000 45.00000
50.00000 35.00000 10.00000 35.00000
25.00000 40.00000 35.00000 5.00000

Matrik Cid (Moda 1)
10.00000 15.00000 25.00000 55.00000
30.00000 10.00000 45.00000 50.00000
55.00000 40.00000 15.00000 40.00000
30.00000 45.00000 40.00000 10.00000

Matrik fid
0.54881 0.40657 0.22313 0.03688
0.16530 0.54881 0.06721 0.04979
0.03688 0.09072 0.40657 0.09072
0.16530 0.06721 0.09072 0.54881

Nilai Bd Konvergen:
0.00020 0.00020 0.00015 0.00012

Nilai Ai Konvergen:
0.73326 0.89939 1.31778 0.99305

Nilai Tid:
1582.07241 2286.90619 966.74605 164.27535
350.68190 2271.83648 214.28877 163.19285
324.83659 1558.97920 5381.74096 1234.44324
1742.40910 1382.27812 1437.22422 8938.08856

Nilai Tidk (Tid Moda k):
560.59738 810.35079 342.56037 58.20993
124.26192 805.01093 75.93187 57.82636
115.10380 552.41445 1906.98597 437.41718
617.41168 489.80154 509.27134 3167.15532

Nilai do fid:
-5.48812 -6.09854 -5.57825 -2.02857
-4.95897 -5.48812 -3.02425 -2.48935
-2.02857 -3.62872 -6.09854 -3.62872
-4.95897 -3.02425 -3.62872 -5.48812

Nilai do Ai(j):
67.15600 81.72722 138.47493 102.70233

```

Figure 5 Output Program (layer 1)


```

C:\WINDOWS\system32\cmd.exe

Nilai do_Tid(i)<j):
12547.39606      10156.56272      -14194.84694      -8509.11184
-4483.37376      19822.82320      -7585.57306      -7753.87638
-7657.21105      -11009.99172     47431.39722      -28764.19445
-406.81126       -18969.39425     -25650.97727     45027.18277

Nilai do_Tidk(i)<j):
826.55833        -1633.16701      -7241.61711      -3390.98623
-2390.96014      1826.48855       -3178.15890      -3120.89672
-3456.45938      -7468.01986      4494.44131       -13016.62251
-4130.50842      -9884.11974      -12377.40454     -4493.83976

Nilai do_do_Ai(j):
16439.94037      111369.08216     156664.49943     134830.16451

Nilai do_do_Bd(j):
2.13278 2.12942 1.95125 1.80759

Nilai do_do_Tid(i)<j):
30882603.64529  44038921.80513  20159211.54760  4029198.06394
42488225.12239  274554564.93093  26449256.91319  20503484.42459
36974122.44935  176317099.62314  616345906.86580  143439447.14966
227389594.79386  180347316.91534  189715139.39188  1188005571.26704

Nilai do_do_Tidk(i)<j):
19295670.98289  21356322.04487  18374987.68699  43736867.57695
16708120.43361  118015096.38168  19251525.24220  24589105.20556
92338255.71888  87267713.81963  336982925.17437  108739728.99439
83566759.64777  127039234.87612  118669445.50786  527716165.01818

Arus akhir pada rute 1: 502.41749
Arus akhir pada rute 2: 129.65613
Arus akhir pada rute 3: 162.07016

Nilai pid tiap l:
0.63265 0.36735 0.16327 0.20408

Nilai f: -3137486.01322
Nilai f: 41030965620.56481

Nilai h: 0.00008
Nilai Beta baru adalah <Beta[n-1]+h>: 0.06008
Press any key to continue . . .

```

Figure 6 Output Program (layer 2)

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