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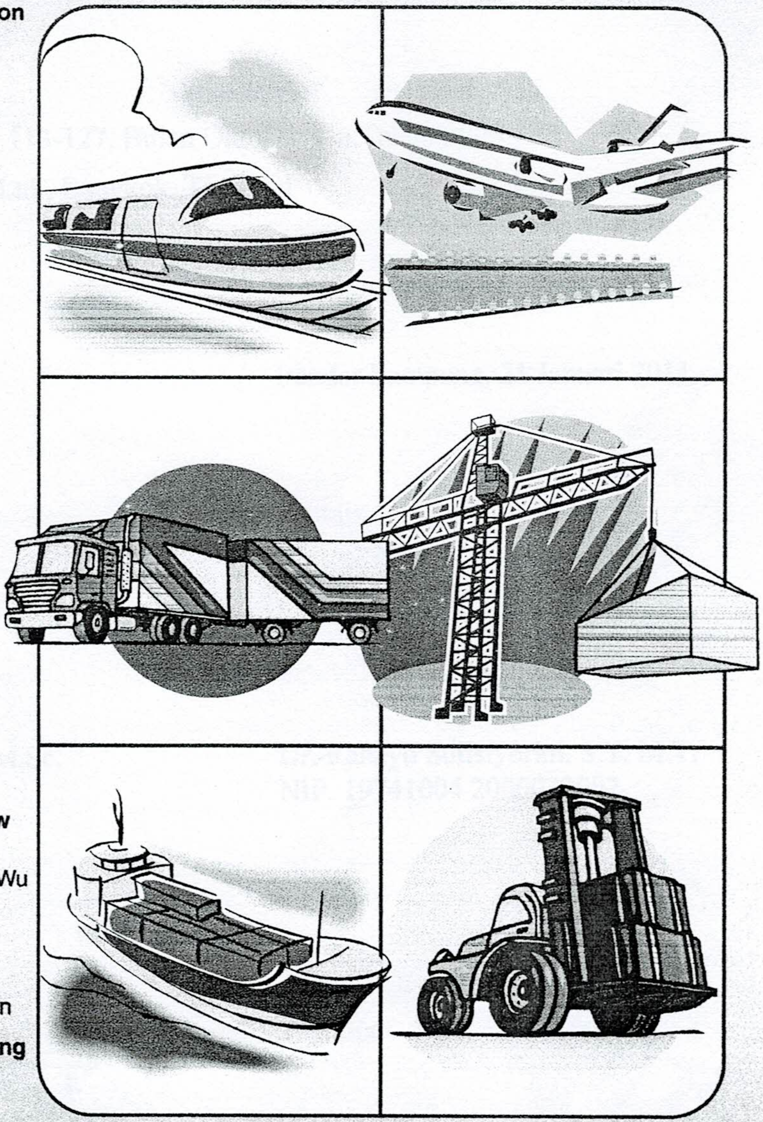

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The Chartered Institute of Logistics & Transport
Thailand

Editors:
Ruth Banomyong
Ungul Laptaned
Walailak Atthirawong

LEMBAR PENGESAHAN

Judul	:	The Application of Gravity Model Combined With Multinomial Logit Model Based under Equilibrium Assignment
Penulis	:	Rahayu Sulistyorini
NIP	:	19741004 2000032002
Instansi	:	Fakultas Teknik, Universitas Lampung
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Mengetahui,
A.n. Dekan Fakultas Teknik
Universitas Lampung
Pembantu Dekan I

Dr. Eng. Helmy Fitriawan, S.T, M.Sc.
NIP. 197509282001121002

Penulis,

Dr. Rahayu Sulistyorini, S.T, M.T.
NIP. 19741004 2000032002

Menyetujui:

A.n. Ketua Lembaga Penelitian
Sekretaris Lembaga Penelitian Unila

Drs. Mardi Syahperi
NIP. 195801001980031001

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Editorial

Welcome to the third issue of the International Journal of Logistics and Transport (IJLT). We, the editors, appreciate greatly the support of the Thai Researchers' Consortium on Value Chain Management and Logistics (Thai-VCML) and The Chartered Institute of Logistics and Transport (Thailand) in asking us to become involved in this endeavor as editors of the IJLT.

Over the past few years we have noticed the rapid development of transport, logistics and supply chain management, and operations research within the industrial, academic and governmental sectors. More and more people are talking, researching and applying transport, logistics and supply chain management, and operations research within a myriad of contexts. There is much excitement in the field.

The IJLT has been established in response to this increased interest in transport, logistics and supply chain management, and operations research issues as a forum for interested parties to advance knowledge and science of the said discipline. The geographical scope of the journal is not solely limited to Thailand and the surrounding region.

This third issue of the IJLT represents a compilation of submitted papers. It is hoped that this issue will set a new benchmark in terms of academic publications in Thailand, especially in the field of transport, logistics and supply chain management, and operations research.

The Editors would like to invite academics, practitioners and policy makers to submit their manuscripts on transport, logistics and supply chain management, and operations research. Through the support of our Editorial and Advisory Board, we hope to be able to provide academic articles of the highest quality to all our readers.

Ruth Banomyong
Ungul Laptaned
Walailak Atthirawong
Editors

The Editors

Ruth Banomyong (PhD)
Ruth Banomyong is an Associate Professor in the Department of International Business, Logistics and Transport Management at the Faculty of Commerce & Accountancy, Thammasat University in Thailand. He received his PhD in 2001, in the field of International Logistics within the Logistics & Operations Management Section (LOMS) at Cardiff Business School (UK). He was the winner of the James Cooper Cup in 2001 for the best PhD dissertation in logistics from the Chartered Institute of Logistics & Transport (CILT) in the United Kingdom. He has published over 50 papers and reports in such journals as International Journal of Physical Distribution and Logistics Management, International Journal of Logistics Research and Application, Asia Pacific Journal of Marketing and Logistics, Maritime Policy and Management, among others, and he has co-authored 3 books. Since 1995, Ruth has been a consultant on transport, logistics and supply chain management for international agencies such as the United Nations Conference on Trade & Development (UNCTAD), the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP), The World Bank, The Asian Development Bank (ADB) and, the Association of South East Asian Nations (ASEAN).

Ungul Laptaned (PhD)
Ungul Laptaned is an Assistant Professor in the Department of Logistics Engineering at the School of Engineering, University of the Thai Chamber of Commerce. He graduated with a Ph.D. in 2003 from the University of Nottingham, United Kingdom in the field of Manufacturing Engineering and Operations Management. Ungul has published over 30 proceedings and journal papers; for instances, Industrial Engineering Network, Asia Pacific Industrial Engineering and Management, International Association of Science and Technology for Development, Operations and Supply Chain Management, Intelligent Manufacturing System, etc. He was a program chair for previous international conference such as the 2nd International Conference on Operations and Supply Chain Management 2007, Bangkok. Ungul has been also assigned as organizing committee in the IASTED International Conference on Web-based Education 2009, Phuket. He is a journal editor of Thai Researchers' Consortium of Value Chain Management and Logistics, and has consulted for several public organizations and industrial firms on logistics and supply chain management such as Thailand Research Fund, Phitsanulok Province, Public Warehouse Organization, Amatanakorn Industrial Estate, Wyncoast Industrial Park, and Iron and Steel Institute of Thailand.

Walailak Atthirawong (PhD)
Walailak Atthirawong is an Associate Professor in Department of Applied Statistics, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, Thailand. She received a Ph.D. in Manufacturing Engineering and Operations Management at the University of Nottingham, England in 2002. Her teaching and research interests include applied operations research, supply chain management, forecasting and location decision.

Foreword

In this third issue of the International Journal of Logistics and Transport (IJLT), the Editors received a number of papers from different countries such as China, Indonesia, Malaysia, Portugal, Thailand, and the USA. The received papers encompassed many areas of transport, logistics and supply chain management, and operations research.

After a reviewing process, a total of ten papers were selected for publication in this third issue of the IJLT. These ten papers can only provide readers with an overview of the scope of the transport, logistics and supply chain management, and operations research papers.

In the first article, entitled ***"Exact Algorithm for the Interval Flow Transportation Problem with Uniform Conditional Lower Bounds"*** conducted by *Aruna Apte*. This paper describes the exact algorithm for solving interval-flow integer networks that utilizes an efficient heuristic approach incorporating the conditional bounds into the simplex pivoting process that exploits the efficient, specialized pure-network simplex technologies [1]. The algorithm is applied to interval-flow transportation problems with a uniform conditional lower bound and tested on problems with up to 250 nodes and 2000 arcs. Empirical comparisons with CPLEX demonstrate the effectiveness of this methodology, both in terms of solution quality and processing time.

The second article deals with transportation issues. This paper is authored by *Cheng-Min Feng and Chia-Hui Chang*, and is entitled ***"Improving Efficiency of Motorcycle Taxi Operation: A Case Study in Bandar Lampung, Indonesia"***. This paper discusses the function of the motor-cycle taxi or ojek in Indonesia as feeder to the formal public transport network to fill the gap left by the inability of the operators to meet the demands for various reasons. A simple scheduling system was applied to improve the operating efficiency in which each driver can make the same number of trips carrying passenger(s) but with much less time and effort to spend. A simple method and mechanism for giving reward and punishment was created to ensure that the scheduling system can be successfully applied and maintained to benefit all the parties concerned.

The third article is co-authored by *Susana Garrido Azevedo and João Ferreira*, and is entitled ***"Strategic Approach of Seaports: Qualitative Evidences of a Portuguese Seaport"***. This paper aims to investigate the strategic approach, in particular the resource-based view and it emphasizes some aspects of strategic management of seaports applying to the case study – Sines seaport. The analysis is based on qualitative research, involving the strategic plan and several other statistic reports of the seaport. Thus, the research was conducted to identify the main determinants of the competitiveness and allowing a strategic evaluation of the seaport: general characteristics, resources and capabilities, and performance.

The fourth paper is co-authored article by *Supakanya Chinprateep and Rein Boondiskulchok*. Their paper is entitled ***"Integrated Purchasing and Production Planning Multi-Workstation Multi-Level Capacitated Lot Sizing Model"***. This research was motivated by problems arising from manufacturing as regards various raw materials and multiple products. The purpose of this study was to develop the capacitated lot-sizing model for purchasing and production planning problem with on-hand inventory consideration in multi-item; multi-period; and multi-workstation situation considering associated constraints of warehouse capacity. This will allow us to model the manufacturing environments as mentioned in a more realistic and intuitive way.

In the fifth article, entitled ***"Research on the Optimal Theoretical Value of Enterprise Logistics Service Level"***, written by *You-heng Huang and Juan Wang*. The paper develops the model aiming at maximum-profit which is used to get the optimal theoretical value of enterprise logistics service level is constructed. Through solving the model, the balance point between logistics service level and logistics cost in the game which is also the maximum-profit point can be achieved. Correspondingly, the optimal logistics cost and composing values of evaluated indexes of logistics service level are achieved which can support enterprises to make a sensible decision on logistics service level and standards.

Article number six is entitled ***"The Analysis and Assessment of Hub and Spoke Implementation: A Case Study of Thai's Industrial Park"***, and is co-authored by *Kanchana Kanchanasuntorn and Nuttanaree Sukseksan*. The objectives of this research work are to study the possibility of load consolidation for an industrial park/estate shipment and to determine the transportation cost saving obtained from the proposed method. In this paper work, the distribution behaviours of overall factories situated in an industrial estate in the North-Eastern part of Thailand are studied first. Transportation data of each factory comprising of 1) type of product; 2) type, size, dimension and weight of logistics packaging; 3) frequency of delivery; 4) amount of delivering product per shipment and 5) special characteristics needed to be considered during delivery are collected and analyzed in order to determine the feasibility of pre-delivering product consolidating.

The seventh article is conducted by *Nindyo Cahyo, Kresnanto Ofyar Z. Tamin, and Russ Bona F.*, and is entitled ***"Path Finding Algorithm on Fuzzy Travel Cost Condition"***. This paper discuss about route finding using fuzzy travel cost approach. In conventional method, travel cost as input in model is expressed in deterministic form. The other way, in fuzzy cost, travel cost represent as range of certain value from under-bound to upper-bound. Path finding process in fuzzy cost, that produces more than one best route in once iteration has been developed based on Dijkstra (1959) algorithm which placed each selected route in certain layers. Layer with selected route is sequenced from "first" best route. This algorithm is named as Dijkstra Multi Layer (DML) Algorithm. At the end, flow assignment has done with calculating fuzzy membership value in each selected route toward to the best route.

Article number eight is by *Joewono Prasetijo, Meor Othman Hamzah, and Ning Wu*, and is entitled ***"Third Method Capacity Analysis: Mixed Traffic Flow at Unsignalized Intersection"***. The authors investigate the conflict technique which is based on pragmatically simplified concept where interaction and impact between flows at intersection is brought through mathematically formulated. Indonesia Highway Capacity Manual-1997 (IHCM-1997) is one of an example of using the empirical approach, however, due to current behavior, e.q. no gap acceptance behavior, unmotorized attendance with 13 classes vehicles and large different speed, no exclusive lanes, no lane discipline and large number of conflict might be expected, therefore,investigation on total basic capacity, C0 and total actual capacity, C of intersection could be necessary to look further. The objectives of this study are to conduct further investigation and review on Indonesia Highway Capacity Manual-1997 relate to capacity at unsignalized intersection, and to develop a new methodology of capacity analysis of unsignalized intersection relate to headway departure under mixed traffic flow.

The ninth article is co-authored by *Rahayu Sulistyorini, Ofyar Z. Tamin, and Ade Sjafruddin*, and is entitled ***"The Application of Gravity Model Combined with Multinomial Logit Model under Equilibrium Assignment"***. The main objective of this research is the application of gravity with multinomial logit under equilibrium assignment. The estimation methods, namely: Non-Linear-Least-Squares (NLLS) will be used to estimate the parameters of transport demand models. The first stage of model implementation is to code the algorithm into computer program, use C++ language. The hypothetical network contents of nodes, 8 links and 4 zones. The output program from experiment results and analysis can be resumed as the mathematical formula of TDMC Model Development can be applied in artificial network. For detailed application in real network with equilibrium assignment, would be use computer software like EMME/2.

Last but not the least, in his article entitled ***"Managing Logistics System and Creating Sustaining Natural-Based Tourism on Koh Lan Coral Island"***. *Taweesak Theppitak* presents a principle of logistics management to tourism industry under the hypothesis that if having efficiently and effectively the move of tourists from Pattaya to Koh Lan, including efficiently providing transport networking system would increase and support the tourism on Koh Lan. Demand forecasting on tourist in next decade was statistically calculated in order to provide improvement of infrastructure systems and facilities to support the growth and expansion of the tourist in next decade. The objective of the study was to examine an appropriate pattern of tourists' demand forecasting on Koh Lan. The information was used for planning and developing infrastructure systems and facilities, including studying transport networking and logistics system to support the future growth of tourists in next decade.

It is hoped that you will enjoy reading these articles and that they will generate responses and discussions that will help advance our knowledge of the field of transport, logistics and supply chain management, and operations research. The Editors and the Editorial Board of the IJLT would like to welcome your future submissions to make this journal your forum for sharing ideas and research work with all interested parties.

Ruth Banomyong
Ungul Laptaned
Walailak Atthirawong
Editors

Contents

The Application of Gravity Model Combined with Multinomial Logit Model Under Equilibrium Assignment

Rahayu Sulistyorini
Ph.D Student, Department of Civil Engineering
Faculty of Civil and Environmental Engineering
Bandung Insitute of Technology Jl. Ganesa No.10 Bandung
Telp: (022)2502350., Fax: (022) 2502350
E-mail: rahayu350@students.itb.ac.id

Ofyar Z. Tamin
Department of Civil Engineering Faculty of Civil and Environmental Engineering
Bandung Insitute of Technology Jl. Ganesa No.10 Bandung
Telp: (022) 2502350, Fax: (022) 2502350
E-mail: ofyar@trans.si.itb.ac.id

and

Ade Sjafruddin
Department of Civil Engineering Faculty of Civil and Environmental Engineering
Bandung Insitute of Technology Jl. Ganesa No.10 Bandung
Telp: (022) 2502350, Fax: (022) 2502350
E-mail: ades@trans.si.itb.ac.id

IJLT International Journal of Logistics and Transport

THE APPLICATION OF GRAVITY MODEL COMBINED WITH MULTINOMIAL LOGIT MODEL UNDER EQUILIBRIUM ASSIGNMENT

by

Rahayu Sulistyorini
Ph.D Student, Department of Civil Engineering
Faculty of Civil and Environmental Engineering
Bandung Insitute of Technology
Jl. Ganesa No.10 Bandung
Telp: (022)2502350., Fax: (022) 2502350
E-mail: rahayu350@students.itb.ac.id

Ofyar Z. Tamin
Department of Civil Engineering
Faculty of Civil and Environmental Engineering
Bandung Insitute of Technology
Jl. Ganesa No.10 Bandung
Telp: (022) 2502350, Fax: (022) 2502350
E-mail: ofyar@trans.si.itb.ac.id

and

Ade Sjafruddin
Department of Civil Engineering
Faculty of Civil and Environmental Engineering
Bandung Insitute of Technology
Jl. Ganesa No.10 Bandung
Telp: (022) 2502350, Fax: (022) 2502350
E-mail: ades@trans.si.itb.ac.id

ABSTRACT

The idea of combining **'traditional'** data sources (home or roadside interviews) with low cost data like traffic counts is not entirely new. 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. The main objective of this research is the application of gravity with multinomial logit under equilibrium assignment. The estimation methods, namely: Non-Linear-Least-Squares (NLLS) will be used to estimate the parameters of transport demand models. The first stage of model implementation is to code the algorithm into computer program, use C++ language. The hypothetical network contents of nodes, 8 links and 4 zones. The output program from experiment results and analysis can be resumed as the mathematical formula of TDMC Model Development can be applied in artificial network. For detailed application in real network with equilibrium assignment, would be use computer software like EMME/2.

KEYWORDS
Gravity, Multinomial Logit Model, Equilibrium

INTRODUCTION

Background

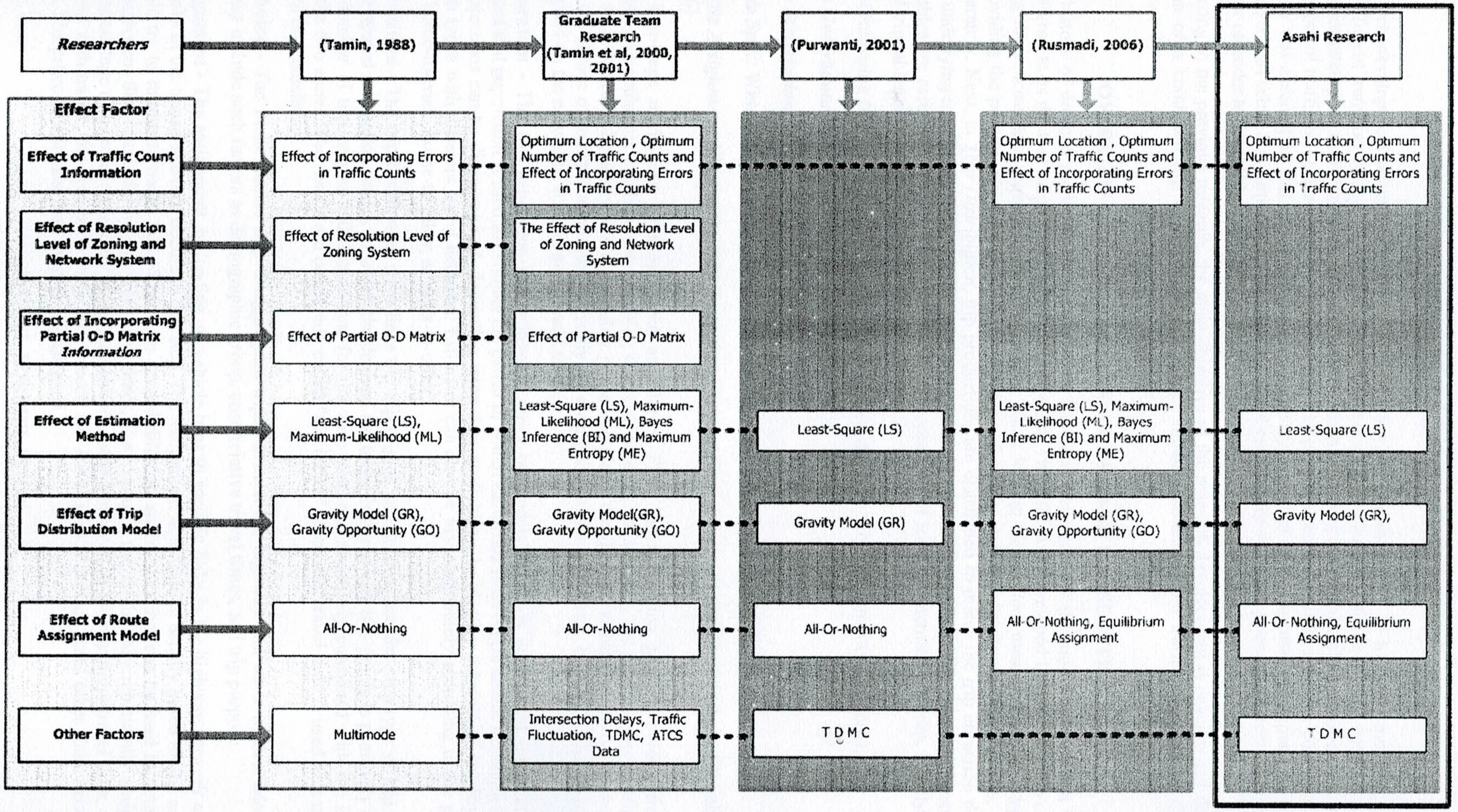
Urban transport study need model to predict movement. On planning work in the context of future time it traffic volume determined from estimation result that use modeling. This traffic volume estimating is very useful for transport network system planning and traffic management. The idea of combining **'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.

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 minimized.

The standard approach of transport demand modeling is well known as the sequential model consisting of trip generation, trip distribution, modal split and trip assignment. The models are analyzed sequentially, where the output of the first sub-model (trip generation) is used as input to the second sub-model (trip distribution) then the output of the second sub-model (trip distribution) is used as input to the third sub-model (modal split).

FIGURE 1

ROADMAP ON TRANSPORT DEMAND MODEL ESTIMATION RESEARCH AGENDA



Objectives

Research development about combination modeling has the important role in transport modeling for use in effective and efficient transport system planning. Route Choice is a major element which has to be considered carefully by travelers 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 perception in considering of route selection.

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.

OVERVIEW OF FOUR-STEP TRAVEL DEMAND FORECASTING

The history of demand modeling for person travel has been dominated by the modeling approach which has come to be referred to as the four step model, or henceforth, 4SM. The 4SM was developed to deal with this complexity by formulating the process as a sequential four step model. First, in *Trip Generation*, measures of trip frequency are developed providing the propensity to travel. Trips are represented as trip ends, productions and attractions, which are estimated separately. Next, in *Trip Distribution*, trip productions are distributed to match the trip attraction distribution and to reflect underlying travel impedance (time and/or cost), yielding trip tables of person-trip demands. Next, in *Mode Choice*, trip tables are essentially factored to reflect relative proportions of trips by alternative modes. Finally, in *Route Choice*, modal trip tables are assigned to mode-specific networks.

Using the following four steps, transportation models answer questions about future travel patterns:

- ***Trip Generation:*** How many trips will be made?
- ***Trip Distribution:*** Where will the trips be?
- ***Mode Split:*** Which modes (automobile, transit, cycle, or on foot) will be used?
- ***Traffic Assignment:*** What routes will be used and at what time of day will the trips be taken? (Beimborn et al., 1996)

The four-stage model can be summarized as follows. First, the generation phase provides, from socio-economical data on population, employment, shopping centre or schools, for instance, the total number of trips leaving and reaching each centroid. Secondly, the distribution phase completes the demand estimation by computing the OD matrix Next, the choice of transportation mode is analyzed during the modal split stage. Finally, traffic flows for each mode are assigned on the networks. It is the assignment stage.

a. **Trip generation** - The trip generation step utilizes a series of models in which zone-based information about employment and population is used to estimate the extent to which each zone is an origin and/or destination for trips. These projections can be disaggregated, depending upon data availability, to identify sub-sets of employment and population types with different travel behavior. Estimates can also be made separately according to the purpose of trip, e.g., home-to-work, home-to-other, or other-to-other.

b. **Trip distribution** - The trip distribution steps links the trip origins and destinations for each type of trip through a gravity, or spatial interaction model, in which the demand for travel between any two points is positively correlated with the number of trip origins and destinations for the zone pair, and negatively correlated with the impedance between the two zones. The results are commonly called "trip tables". Typically travel time is used as a measure of impedance or accessibility.

c. **Modal choice** - The mode choice step disaggregates trips between the highway and other modes. Mode choice models may include such factors as demographic group, cost, relative travel times, and trip purpose.

d. **Trip assignment** - The assignment, or loading, of vehicle trips to specific links in the highway network and person trips to links in the transit network occurs in this step. The assignment algorithm is usually based on the assumption that people try to minimize travel time. There are several different approaches that can be used to determine the traffic assignment that results in the smallest travel times. For example, the model may repetitively assign a user-selected percentage of trips incrementally along the network paths that result in the minimum travel time. As certain links fill up with traffic, the speeds on them are reduced and travel time increases, until other links become more attractive. The process continues until all trips are assigned.

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 tha particular link l (V_l) can be expressed as follows:

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

In this reserch, 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:

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

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

$$T_{id} = \sum_m \left(O_i^m . D_d^m . A_i^m . B_d^m . f_{id}^m \right) \qquad (3)$$

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

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

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:

$$T_{id}^k = T_{id} . \frac{\exp\left(-\gamma_k . C_{id}^k\right)}{\sum_m \exp\left(-\gamma_m . C_{id}^m\right)} \qquad (5)$$

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:

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

d. ***Estimation Method***

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)

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:

$$\text{to minimise} \quad S = \sum_{l} \left[V_l^{+k} - V_l^{k}\right]^2 \tag{7}$$

$\hat{V}_l^{k}$ = **observed traffic flows for mode <u>k</u>**

V_l^{k} = **estimated traffic flows for mode <u>k</u>**

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)**:

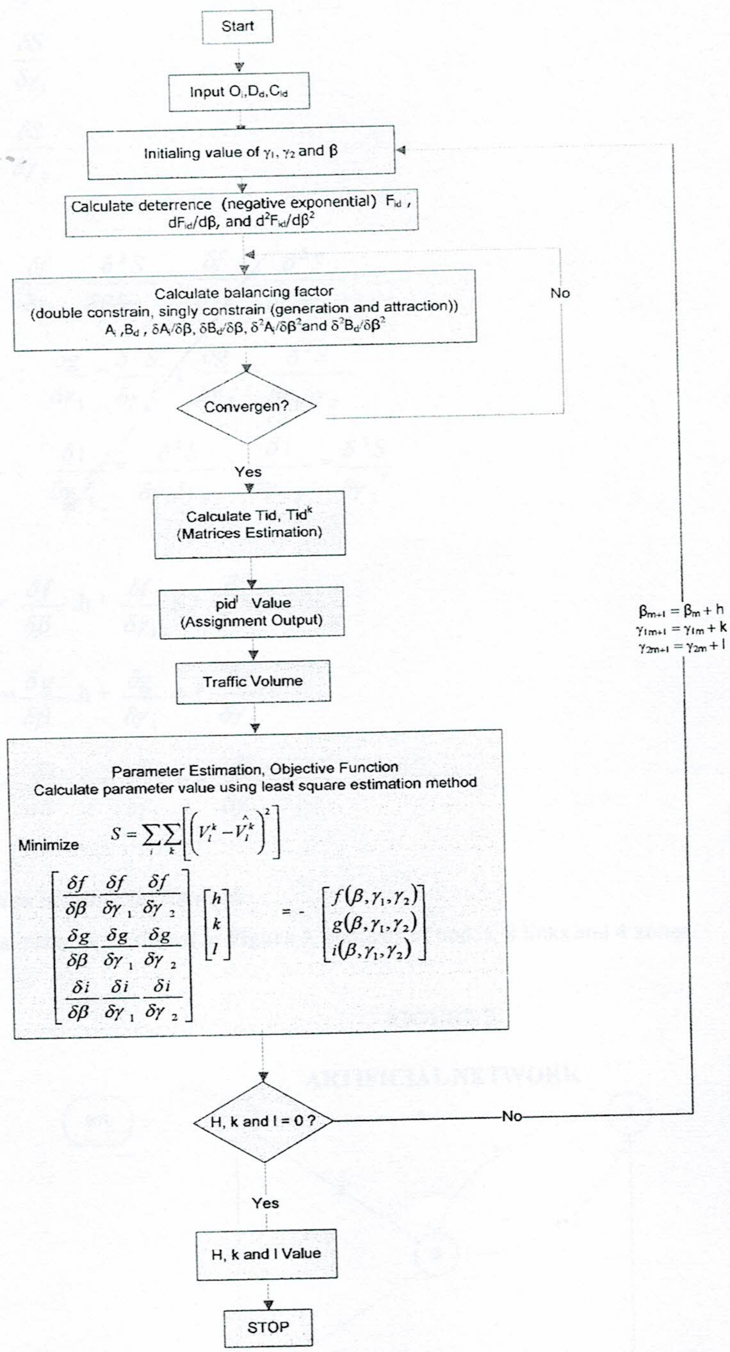
$$\frac{\delta S}{\delta \beta} = \sum_{l} \left[\left(2 \sum_{i} \sum_{d} T_{id}^{k} \cdot p_{id}^{lk} - V_l^{k} \right) \left(\frac{\sum_{i} \sum_{d} \delta T_{id}^{k}}{\delta \beta . p_{id}^{lk}} \right) \right] = 0 \tag{8}$$

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)**.

e. ***Newton–Raphson's method and the Gauss–Jordan Matrix Elimination technique***

FIGURE 2

NEWTON–RAPHSON'S COMBINE WITH THE GAUSS–JORDAN MATRIX ELIMINATION TECHNIQUE



Furthermore O-D Matrices Elimination Technique concept could be implemented in the following algorithm. (see **Figure 2.**) For futher explanation , is shown as bellow

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

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

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

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

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

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

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

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

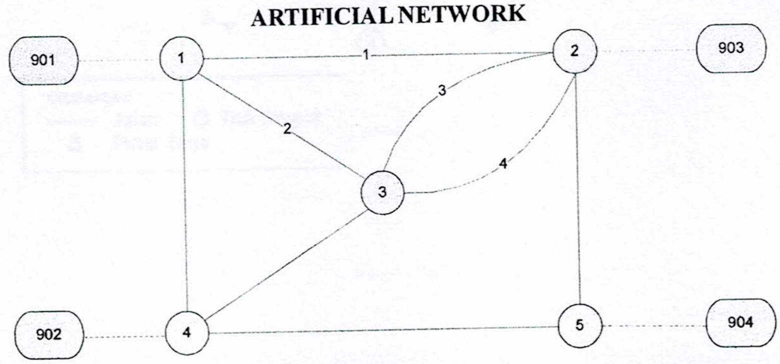
$$i(\beta, \gamma_1, \gamma_2) = \frac{\delta i}{\delta \beta}.h + \frac{\delta i}{\delta \gamma_1}.k + \frac{\delta i}{\delta \gamma_2}i$$

f. Application in Artificial Network

The hypothetical network as shown in **Figure 3**, contents of nodes, 8 links and 4 zones.

FIGURE 3

ARTIFICIAL NETWORK



The first stage of model implementation is to code the algorithm into computer program. This computer program use the coding with C++ language.

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

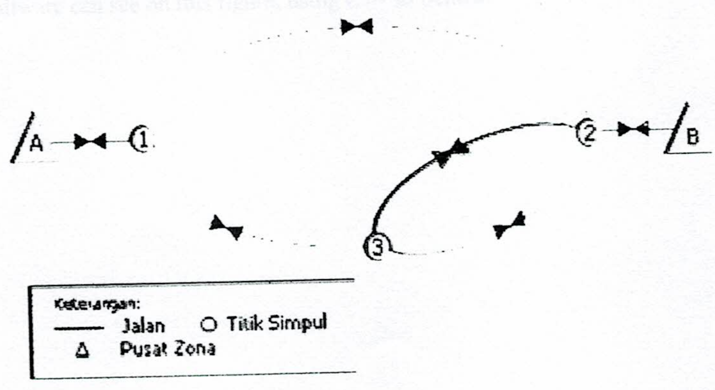
$$C_{id} = \frac{\left(C_{id}^1 + C_{id}^2\right)}{2}$$

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:



Where:

$$p_{id}^1 + p_{id}^2 = 1$$
$$p_{id}^1 + p_{id}^3 + p_{id}^4 = 1$$

$T_{12} = 810$

Cost Function in each route is:

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

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

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 bellow:

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 (Fi) value
4. Calculate volume existing

$$V_l^{(n)} = (1 - \phi).V_l^{(n-1)} + \phi.F_l$$

ϕ : Parameter (with value = 0-1)

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

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

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

5. Calculate new travel cost base on flow $V_l^{(n)}$. 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 ($V_l^{(n)}$) is assigned. The process is repeated until convergence.

ϕ = 1/ sum of repeated = 1/n

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

FIGURE 5

OUTPUT PROGRAM (LAYER 1)

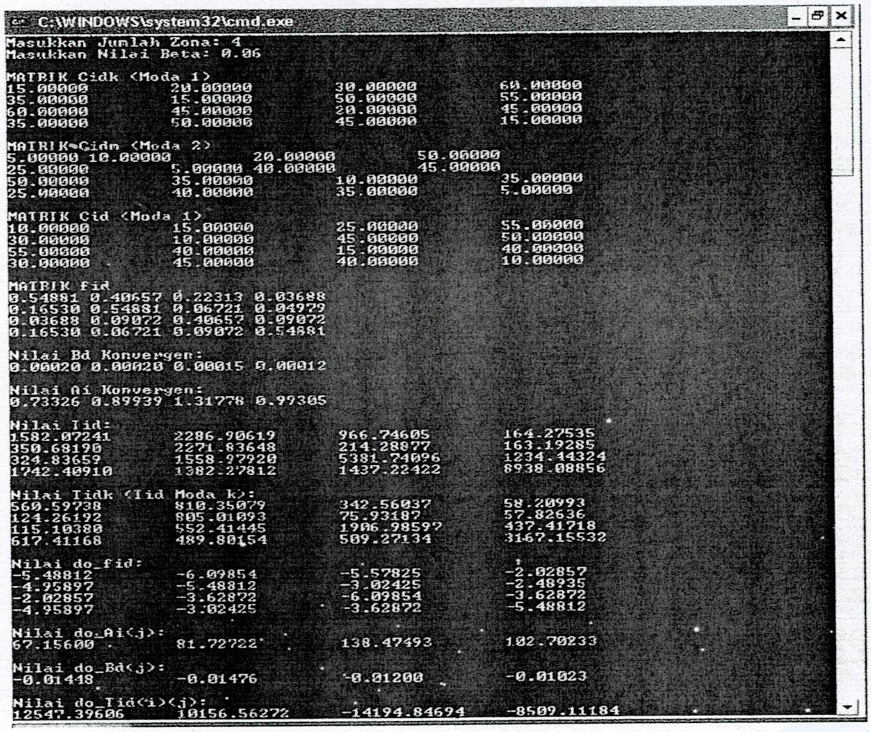
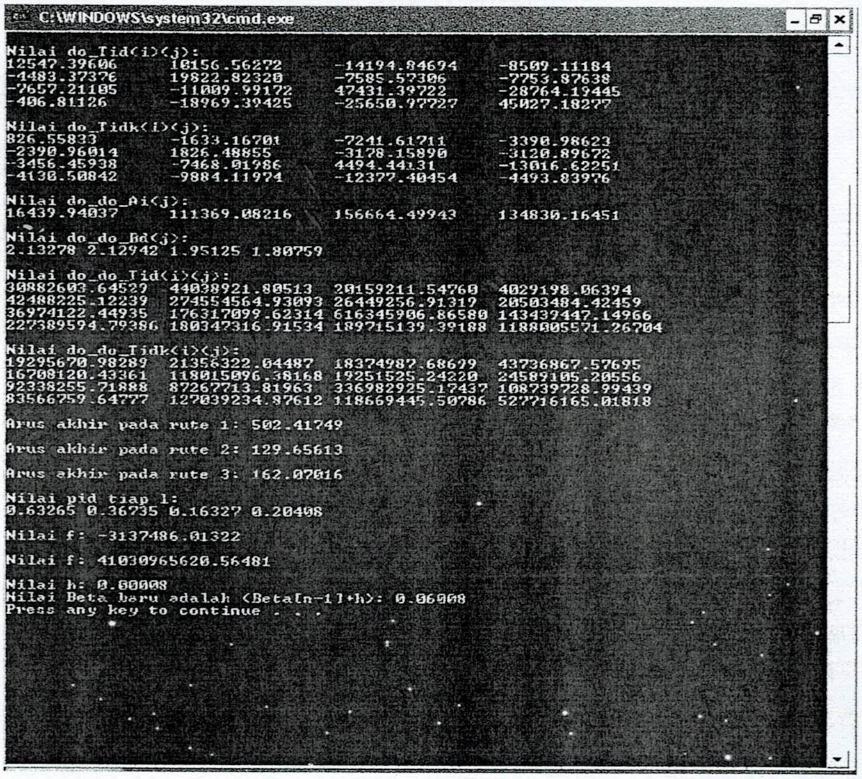


FIGURE 6

OUTPUT PROGRAM (LAYER 2)



CONCLUSIONS

The output program from experiment results and it analysis it can be resumed as the mathematical formula of TDMC Model Development can be applied in artificial network. For the detailed application in real network with equilibrium assignment, would be use computer software like EMME/2.

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ABOUT THE AUTHOR

Rahayu Sulistyorini is a lecture in Lampung University at the Civil Engineering Department since 2000 until now. She got graduate program in Gadjah Mada University, Indonesia from 1993 until 1998. She received her master in Transportation from Institute Technology Bandung, Indonesia. Now, she is PhD student in Institute Technology Bandung. Her research interests are public transport services and modeling transportation. She has published in the Eastern Asia Society Transportation Studies Proceeding, Symposium of Inter-Universities Forum on Transportation Studies Proceeding, European Asian Civil Engineering Forum Proceeding, Mediats Journal. Also, she presented papers at the educators' National Conference Civil Engineering, Transportation and Geotechnic Seminar, European Asian Civil Engineering Forum and ASPAC seminar.