DETERMINATION PRIORITY OF ROAD IMPROVEMENT ALTERNATIVES BASED ON REGION OPTIMIZATION CASE STUDY : BANDUNG CITY INDONESIA

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Abstract: At the big or metropolitan city in Indonesia, road infrastructure development just based on service demand approach or known as "trip follow the trade" approach . Consequently of this approach is land use changed that cannot able to control by the regulator, we call those land use changed is "ribbon development". The other effect of this approach is agglomeration in economy and activity happened. As the result is utility of certain region is very different among the others and in-efficiently of the commuting trip in the city. Based on this reason we need a kind of approach that can make all of the region utility will be uniform.

As the analyse method, we use the Analythical Hierarchy Process (AHP) Method,. The intention or the objective of this analysis is optimization region utility by finding the strategic or model that can use to choose the priority of road development alternatives among the alternatives that have been planned. The direction of this strategic is efficiently in road development and equilibrium in utility of all region or region in the city, as the optimization criteria. Consideration to choosen the criteria is depend on the objective of this analysis.

As the objective of the study that explained above, construct the hierarchy, determine the actor (decision maker), Criteria chosen based on initial survey, and then we calculated the weighted of the criteria with standard procedure of AHP. So we have linear model of utility function based on the weighted of each criteria.

In this research we get the criteria that influence decision maker to determine the priority are ratio of Bussiness density, ratio of population density , ratio of accessibility to Central Bussiness District and ratio of average accessibility to other regions. The accessibility is trip time that generated by four step transportation model.

Key Words : Optimization, Land Use, Decision Criteria, Accessibility and Road Development.

1. INTRODUCTION

Road infrastructure development approach that arrange by government recently just based on level of service of the road. Road improvement has taken on the road with low level of service that indicated with traffic congestion. This approach is based on principal that supply service on demand or well known with "*ship follow the trade*". Consequence of this approach is accessibility of centre region become better and the other side the region with bad accessibility become worst, the demand on centre of region become higher as consequnce of the better accessibility to the centre of the region or well known with *"trade follow the ship."*

Improvement of road infrastructure has given impact "ribbon development" that growing of demand or land use changed on the side of the road that improved. Land use changed has direction to the more intensive land use like residential area change become to bisnis area as trade centre or office centre. Land use development on the side of the road will decreasing level of service of that road and so on. The other impact of recent approach is region utility on the centre relatively more higher then the other location of the region.

Based on those problem, we can get conclusion that need the other approach on road infrastructure development that approach isn't based just on level of service of the road but either consideration on some criterion such as level of land use density, trip generation and attraction and accessibility of the regions.

## 2.AHP METHOD AS ANALYSIS APPROACH

Determination analysis of road network priority was choosen involve with some decision maker and some criterion thet would be consideration by objective to improve road network that can give efficiently in traffic movement and equilibrium on region utility in the city. The priority that chosen based on alternatives that offer in the analysis. Result of that analysis is the decision that the of the city road network that has priority to improve. The decision isn't depend on the problem that want to solve and the actors that involve but either the interaction from the following stage as definon of criteria, preference model, definition problem and aplication of decision method (Vincke, 1989).

The reasoning of AHP (Analytical of Hierarchy Process) become the analysis method in this case is because AHP can describe decision making process by human and AHP is one of the method that can give logically consintency in determination of priority road development. Human have capability to act of determining relation between object or between thinking until it will be come coheren that the object or that thinking become well relate each other and its relation show the consistency (Saaty, 1994). AHP ally between judgement and personal evalution in logical manner that depend on the personal experience to stucture modelling hierarchy (Syanti,2002).

The objective of this analysis is to get the strategy for determination priority of road network that need to improve, with AHP analysis to reach some goals as :
- Road improvement can do efficiently with not any problem that appear that can load that road network on the next time.
- The development still doing until reach even distribution development on the whole city region (utility even distribution) that we call region optimization.

AHP method is the method that able to solve the multi objective problem and multi criteria based on comparison preference from each element in funtional hierarchy. Structure of determination on road improvement priority as shown in figure 1 as follows.
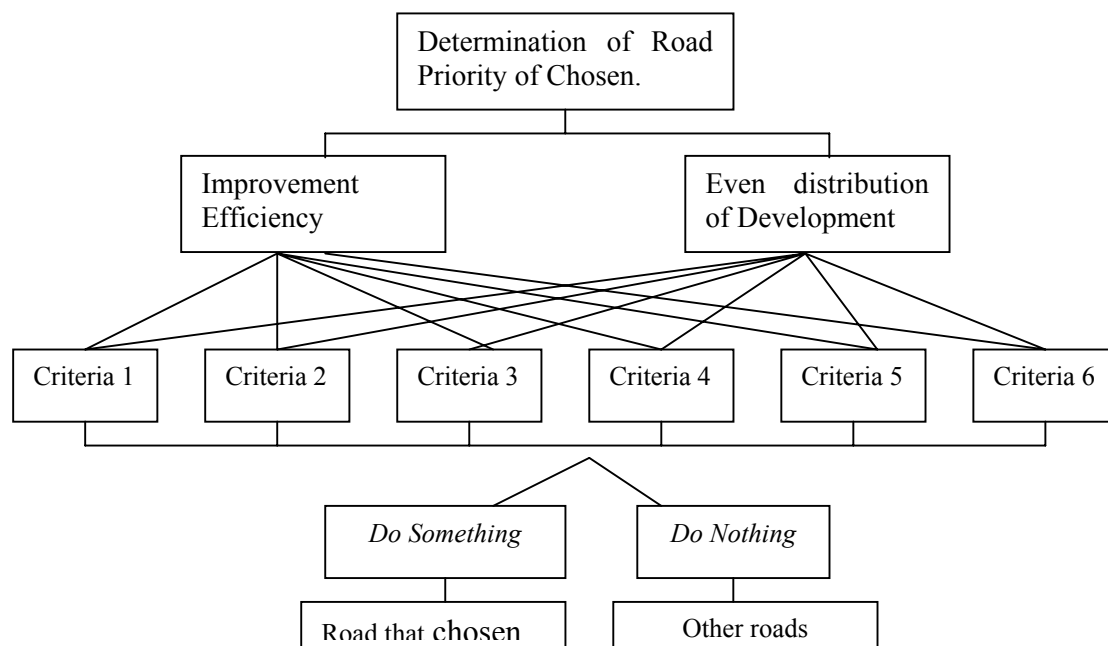
Figure 1: Structure of Determination Road Infrastructure Priority

Criteria on the figure 1 above got from prelimenary survey that will be describe after this. Based on analysis with AHP method then get solution problem alternatives consist of determination of link of road that will be improve (do something) and do not improve any road (do nothing). Methodolology of problem solution shown in figure 2 as follows.
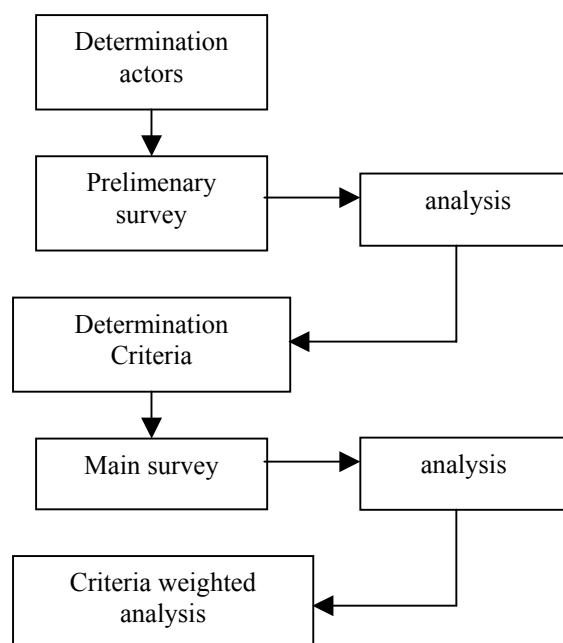
Figure 2. Metodology of Problem Solution

At figure 2 above that can see from analysis of prelimenary survey is determination of criteria and from analysis of main survey is determination of weighted of each criteria that as coeficient of the utility model.

3.DETERMINATION OF ACTORS AND CRITERIA

Decision maker in this case is policy maker on development road network infrastructure that is dinas Tata Kota and dinas Pemukiman dan Prasarana Wilayah (Kimpraswil). Criteria must be include all of the consideration of the two Indonesia government body above to determination priority of road improvement. Criteria must consider of area of influence from the choice and the impact of the period. Basicaly, criteria can has quantitative or qualitative characteristic (Saaty, 1994) such as :
- attainability criteria
- veto/sieve criteria
- desirability criteria

Attainability criteria is operational criteria, sieve criteria is to get and to choose criteria and desirability citeria is to reach the objective of the analysis.

One of criteria's characteristic is its relation with the key problem that faced. Every criteria must answer one of the important question about how good that alternative will can solve the problem faced. Criteria use to compare impact that be estimated will appear from every alternative that exist.

Besides of that need to consider the following item to determination criteria as the coeficien model as :
- Linierity effect
- Appropriate the value of criteria that can give realism exist condition.
- Caused by accessibility is relative measurement that accessibility has ratio scale.

Determination of criteria can do deductive (from general condition to specific condition)or inductive (from specific condition to general condition) or combination of both, the criteria that got from prelimenary survey shown in table 1. We can see from tbale 1 all of the criteria has ratio scale that caused by certain region utility is relative of the other region utility in the same city.

Table 1 : Criteria and their direction with region utility

Criteria	Description	Direction with region utiliy
RAC	Ratio travel time to city centre by average travel time all region to city centre	Negative
RAT	Ratio average travel time to each region by average travel time in the city.	Negative
RBP	Ratio Trip generation by average trip generation in the city	Positive
RTP	Ratio trip attraction by average trip attraction in the city	Positive
RKP	Ratio residential density by residential density planning	Positive
RKB	Ratio employment density by employment density planning	Positive

4.DETERMINATION WEIGHTED OF CRITERIA

The method approach to calculate weighted of criteria or the coeficient of region utility equation, are :
- Preference analysis or stated preference
- Behavioural analysis atau revealed preference
- Direct System
- Indirect System

Saaty, 1994 decided quantitaive scale from 1 to 9 to evaluate comparison level of urgency one element from others as shown in table 2.

Table 2 : Comparison of level of urgency

Intensity of Urgency	Description
1	Both element have same level of important
3	Certain element little more important than the other
5	Certain element more important than the other
7	Certain element clear more important than the other
9	Certain element absolutly more important than the other
2,4,6,8	Value between the above value
ViceVersa	If activity i has value than activity j so activity has value vice versa from activity i

Source : Kadarsah (1998).

From main survey by stated preference questionaire each actor take apart in determination land use policy by ranking scale. Intensity of urgency is level of urgency certain criteria from other criteria. Priority value is total value of certain criteria that has normalisation. Coeficient of utility model got from average of ranking value of all actors.

5.CRITERIA SELECTION

To optimalize AHPm usage, need initial selection of the criteria that have chosen. Maggie C.Y. Tam and VMR Tummala introduce the method to ensure level of urgency of criteria is call Cut Off method. Based on this method evaluation of this criteria consist of three part, if certain criteria is very important has score three, more important has score two and less important has score one (Tam & al, 2001). Evalution conducted by questionaire that distributed to all actors. The criteria that has score less than cut off score will eliminated from analysis. Calculation of Cut Off Score by formula as shown at equation 1.

$$Cut\ Off\ Score\ =\ (maximum\ score + minimum\ score)/2 \qquad (1)$$

Criteria that has score more than cut off score as shown in the table 3. At table 3 we can see there are four criteria that have score more than cut off score. Those criteria be continued to analyse and will be atribute in utility model.

Table 3 : Criteria Selection

Criteria	Very Important	Important	Less Important	Total Score	Total Evaluator	Average
RAC	2	4	-	14	6	2,33
RAT	3	2	1	14	6	2,33
BP	-	2	4	8	6	1,33
TP	1	3	2	11	6	1,83
RKP	4	2	-	16	6	2,67
RKB	3	3	-	15	6	2,50

Cut Off Score = (2,67 + 1,33)/2 = 2,00

From that cut off score criteria BP (trip generation) and TP (trip attraction) must be out of the model because their average score less than 2. Then residual criteria are RKP, RKB, RAC and RAT as atribute region utility equation as shown in equation 2.

$$SW = \beta_1.RKP + \beta_2.RKB + \beta_3.ACBD + \beta_4.AT \qquad (2)$$

Where :
RKP = Ratio residential density by residential density planning
RKB = Ratio employment density by employment density planning
RAC = Ratio travel time to city centre by average travel time all region to city centre
RAT = Rasio average travel time to each region by average travel time in the city
$\beta_1 \dots \beta_6$ = coeficient of model

6. DETERMINATION OF MODEL COEFICIENT

After determination of criteria model then be continued by determination weighted of criteria as coeficient region utility equation. Procedure to determination of coeficient model start from make comparison matrics of criteria as shown in table 4 below.

Table 4 : Comparison Matrics of Criteria

Kriteria	RAC	RAT	RKP	RKB
RAC	1	0,667	0,277	0,360
RAT	1,667	1	0,360	0,443
RKP	3,610	2,778	1	0,943
RKB	2,778	2,257	1,833	1
Total	9,055	6,702	3,470	2,746

After comparison matrics of criteria be continued by matrics of normalisation criteria as shown in table 5.

Table 5 : Matrics Normalisation of Criteria

Kriteria	RAC	RAT	RKP	RKB	Jumlah	Rata-rata
RAC	0,111	0,100	0,080	0,131	0,422	0,106
RAT	0,184	0,149	0,104	0,161	0,598	0,150
RKP	0,399	0,415	0,288	0,343	1,445	0,361
RKB	0,307	0,337	0,528	0,364	1,536	0,384

Weighted of each criteria is priority vector that calculated from average, that is **RAC = 10,6% , RAT = 15,0% , RKP = 36,1% dan RKB = 38,4%.**

7. CONSISTENCY TEST

After we get the coeficient of region utility equation, then be continued by consistency test to see level of consistency of coeficient. Saaty decide that comparison matrics is consistent if consistency ratio (CR) not more than 0.1 or 10%. CR value is ratio between consistency index (CI) by random index (RI).

Step of calculation Consistency Index as follows :
- Multiply comparison matrics by its priority vector.
- Divide each cell of vector by each cell of its priority vector

Then find Λ_{max} :

$$\Lambda_{max} = \frac{4,189 + 4,180 + 4,219 + 4,372}{4} = 4,24$$

Calculate Consistency Index (CI) :

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{4,24 - 4}{4 - 1} = 0,08$$

Finally calculate Consistency ratio (CR) :

$$CR = \frac{CI}{RI} = \frac{0,08}{1,11} = 0,072$$

CR is less than 0.10 that is mean the coeficient is consistent and the actors as the decision maker have given the consistent value of the criteria. So the region utility equation as shown in equation 3 below.

$$SW = 0,361.RKP + 0,384.RKB - 0,106.RAC - 0,15.RAT \qquad (3)$$

RKP and RKB as variable that shown land use growth, RAC and RAT as variable that shown travel growth.
The difference sign of land use variable and travel variable shown the competion of strategic demand promoting and demand servicing.

Application of this region utility equation to give even distribution of utility to all region in the city through improvement road infrastructure. Consequency of this strategic is distribution of population and employment will be traverse all of the region in the city.

9.CONCLUSION

- Perception of both dinas as actors are near the same of criteria that influence priority of improvement road infrastructure.
- Priority of road infrastructure improvement more influencing by region density than level of service of the road.
- By this strategic equilibrium in region utility in the city can be reached.

10. RECOMMENDATION

- Scope of actors can be wider with participant of parlement and non government officer that has relation with the problem.
- The equation of utility region is better based on scale of the city.

REFERENCES

a) Books and Books Chapter

Brotchie JF, et.al.(1980)   **Technique for Optimal Placement of Activities in Zones (TOPAZ)**, Berlin Heidelberg New York.

Hadi,G.K (1995) **Dampak Perubahan Guna Lahan Terhadap Kinerja Jaringan Jalan, Lalu Lintas dan Biaya Perjalanan**, Tesis, ITB.

Cochran, W.G. and Cox, G.M. (1968) **Experimental Designs**, John Wiley & Sons,Inc., New York.

Philippe Vincke (1989) **Multicriteria Decision Aid**, John Wiley & Sons Ltd, West Sussex,England.

H.Susilotomo (1987) **Penerapan Proses Analitis Hirarki pada Usaha Penentuan Prioritas Pengembangan Sistem Industri Nasional**, Tesis, ITB.

Kombaitan,B.(1999) **Perubahan Struktur Ruang Perkotaan dan Perkembangan Pola Ruang Pergerakan Bekerja,** Disertasi, ITB.

Musa,I.(2000) **Peranan Faktor Lokasi dalam Pemilihan Lokasi Industri Para pemanfaat Kawasan Industri di Indonesia**, Disertasi, ITB.

Rejeki,T.R.(2000) **Pedoman Penentuan Indeks Perubahan Pemanfaatan Lahan Sebagai Penerapan Permendagri No.4 Thun 1996**, Tesis, ITB.

Santoso,I.(1986) **The Developmentof Microcomputer version Of Leeds Integrated Land Use – Transport (LILT) Model**, Thesis, University of London.

Syanti Dewi (2002) **Kombinasi AHP dengan Skala Rating Kekritisan dalam Penentuan Prioritas Pemeliharaan Pencegahan (PM) untuk Alat Berat Timbang**, Tesis, ITB.

Tamin,O.Z.(1997) **Perencanaan & Pemodelan Transportasi**, Penerbit ITB.

Webster,F.V, et.al.(1990) **Urban Land Use and Transportation Interaction**, Gower Publishing Company.

b) Journal papers

Lubis,H.A.S. & Karsaman,R.H.(1997) **Krisis Perencanaan Transportasi Kota**, Perencanaan dan Manajemen Transportasi, Jurnal PWK.Vol. 8 no.3.

Kombaitan,B.(1995) **Perijinan Pembangunan Kawasan dalam Penataan Ruang**, Aspek Hukum dalam Penataan Ruang, Jurnal PWK no. 17.

Parengkuan,E.P.(1991) **Studi Permasalahan Pajak Lahan Kota dalam Kaitannya dengan Penggunaan Lahan dan aspek Pengendalian Guna Lahan di Kotamadya Bandung**, Jurnal Perencanaan Wilayah dan Kota, no.2 Triwulan 1.

Sujarto,D. (1992) **Wawasan Tata Ruang**, **Wawasan mengenai Tata Ruang dan Pembangunan**, Jurnal PWK Juli, Edisi Khusus.

Tamin,O.Z, Russ,B.F.(1997) **Penerapan Konsep Interaksi Tata Guna Lahan-Sistem Transportasi dalam Perencanaan Sistem Jaringan Transportasi, Perencanaan dan Manajemen Transportasi**, Jurnal PWK.Vol. 8 no.3.

Winarso,H.(1995) **Tarif Ijin Perubahan Guna Lahan Perkotaan Sebagai Bentuk Kontrol Pelaksanaan Penataan Ruang Kota**, Aspek Hukum dalam Penataan Ruang, Jurnal PWK no.17.

c) Papers presented to conferences

Najid et.al.(2002) **Pengaruh Transportasi pada Pemilihan Lokasi Tempat Tinggal di Kota Bandung**, Proceeding Of FSTPT_V, University of Indonesia, November 2002.

Najid et.al.(2003) **Pengaruh Transportasi pada Pemilihan Lokasi Retail di Kota Bandung**, Proceeding Of FSTPT_VI, University of Hasannudin, September 2003.

Najid et.al (2003) **How Transportation Influences The Interaction Residential and Bussiness Allocation In Bandung City Indonesia**, EASTS Conference, Fukuoka, Japan, November 2003.

Najid et.al.(2004) **Pengaruh Transportasi pada Pemilihan Lokasi Perkantoran di Kota Bandung**, Proceeding of FSTPT_VI, University of Parahyangan, September 2004.

Najid et.al.(2004) **Hubungan Transportasi dan Harga lahan untuk Lokasi Perumahan dan Bisnis di kota Bandung**, Proceeding of FSTPT_VI, University of Parahyangan, September 2004.

d) Others documents

Bappeda (1998) **Studi Sistem Transportasi Terpadu di Kotamadya DT II Bandung**.

Bureau of Transport Economics (1998) **Urban Transport Models**, Department Of Transport and Regional Services.

Najid et.al.(2004) **Hubungan Transportasi dan Harga lahan untuk Lokasi Perumahan dan Bisnis di kota Bandung**, Proceeding of FSTPT_VI, University of Parahyangan, September 2004.