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DEVELOPMENT OF A CHOICE MODEL FOR EVALUATING SUSTAINABLE URBAN FORM

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Abstract: We propose a choice model dealing with the residential location and commute trip mode. The model has been estimated by using stated preference data collected via a household survey conducted in the Jabotabek metropolitan area (Indonesia) in 2003. In the survey, households chose one of three hypothetical residential areas and one of three commuter trip modes– car, bus or train– based on an assumption that the head of a household is working in the city center. Three residential areas, i.e., compact, transit-oriented, and suburban are designed by changing the composition of land use within certain distances to home location. The estimated models suggest that sustainable residential land uses, i.e., compact and transit-oriented support transit services mostly. But residential choices made on these sustainable forms are highly conditioned whether they are close to the work location or not. In addition, land use variables that refer to relative distances to different activity centers also support sustainable urban forms.

Key Words: Compact city, transit oriented development, suburban development.

1. INTRODUCTION

Urban forms has various effects on the uses of motorized and non-motorized travel modes[1] (e.g., Banister, 1992; Kenworthy and Laube, 1996; Newman and Kenworthy, 1999; Jenks *et al*., 1996, Cervero, 2002). Dieleman *et al*. (2002) report that defining the relationships

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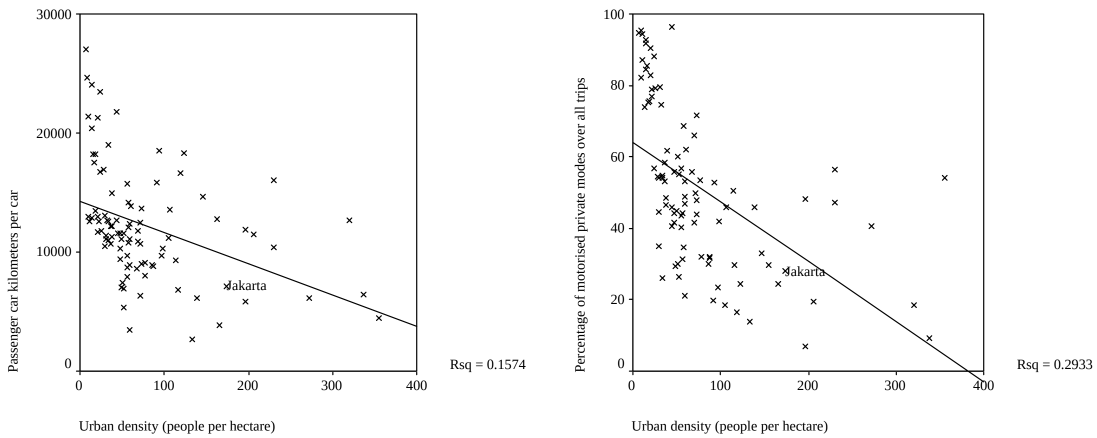
[1] Examples of comprehensive reviews on built environment and travel behavior are Anderson *et al*. (1996), Badoe and Miller (2000), Crane (1999), Ewing and Cervero (2001), Handy (1996), Steiner (1994) and Stead *et al*. (2000).

between urban forms or land use composition and the mode of travel as well as vehicle kilometers traveled is a complicated task as very diverse sets of factors come into play: firstly, travelers hold different personal and household attributes, income, household composition, and participation in the workforce, which have strong impacts on mobility and modes employed; secondly, residential location, residential environment and the transportation services the residential location is endowed with affect travel behavior; and thirdly, trip purpose, space-time constraints and land use affect the chaining of trips, which strongly affects mode(s) utilized (Dieleman *et al*. 2002, pp. 507-508).

It is generally recognized that air pollution, high energy consumption, and uneven urban development are the general effects of heavy dependence on motorized transportation, especially automobile transportation. Thus automobile transportation has attracted considerable focus in sustainable development studies. Heavy use of automobiles in low density urban areas is closely related to the phenomenon termed as automobile dependency. Because, in low density and sprawled urban areas, public transit facilities remain in poor accessibility to most residents; contrary to the public transit, whereas automobile is flexible and offers increased accessibility and mobility. Mainly in low density and sprawl type urban areas, trips are highly dependent on automobiles (Figure 1). In this regard, planners in recent years have sought to contain suburban sprawl and its negative social, economic, and environmental effects some of which are given above. It is expected that increases in energy shortage and air pollution will require actions to reduce motorized transport of people and cargo (Goodwin, 1996; Sperling, 1995).



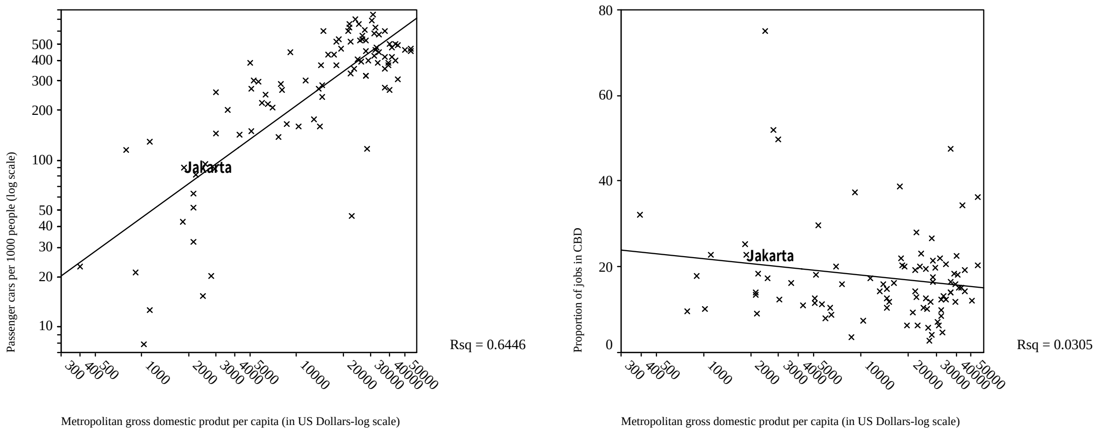
a b

Figure 1. Passenger Car Kilometers per Car (a) and Percentage of Motorized Private Mode (b) with respect to Urban Density (Source: Millennium Cities Database).

To achieve reductions in motorized transport in urban areas, a series of interrelated policies and ideas have been developed. These range from downtown revitalization projects to new urban growth strategies such as New Urbanism, Smart Growth, Compact City, and Transit-Oriented Development (TOD). These strategies generally share a common motive, which refers to the effective use of land to reduce auto trips, promote non-motorized travel (walking and biking), and increase transit patronage.

In general terms, it can be said that urban land use in developing countries is lagged behind the developed countries. We can say that same problems such as automobile dependence, air pollution, etc. might occur in developing cities at levels no less than the levels observed in developed cities. Besides cities in the developing countries are growing rapidly, thus it is crucial to establish and promote the lineage of environmental sustainable policies of urban growth in these cities too.

Currently in developing countries, the real problem is not the high use of automobiles, but the poor service quality of the public transit. Regarding transit problems, policies that depend on public transport schemas like Bus Rapid Transit (BRT) or specialized bus lanes might allow cities in the developing world to develop extensive, affordable and sustainable transit systems. But it can be anticipated that as incomes increase in these countries, variety and composition of urban life bourgeons and improves. Then, it might be expected that automobile ownership increase along with low density urban growth, homogenous land use and the availability of adequate transit services. With similar development paths, e.g., in terms of income increase, it is highly probable that developing countries will also enter the vicious cycle of motorization and urban sprawl as developed countries of today once did (Figure 2).



a. b

Figure 2. a. Logarithm of Car ownership and b. Ratio of Jobs in the City Center with respect to Logarithm of Metropolitan Gross Domestic Product in Various Cities Around the World (Source: Millennium Cities Database)

In this study, we propose a choice model based on a Stated Preference (SP) household survey conducted in Jabotabek Metropolitan Area of Indonesia. The reason for using SP data is given above partially– neither well-defined residential areas nor commuter mode variation exist in the developing countries that might allow us to make assessments based on data collected from real life. In the SP survey, surveyed households are presented with three hypothetical residential areas and three commuter trip modes, based on the information, a residential area and a commuter trip mode is selected. Besides SP data, we have also collected data on what kind of residential area respondent households are currently living. In the choice models, we assume attributes of the existing residential area as the asset position, and we assess the effects of differences between actual and imaginary residential areas.

2. JABOTABEK METROPOLITAN AREA

The Jabotabek metropolitan area stretched on 6580km^2 of land is one of the largest metropolitan areas in the world in terms of population size. According to a transportation study conducted by Japan International Cooperation Agency (JICA) in 2002, the whole Jabotabek area has a population at around 21.5 million. The whole metropolitan area is comprised of the capital city of DKI Jakarta and its three neighboring provinces, Bekasi, Bogor and Tangerang (Figure 3) constitutes 10% of the population of Indonesia. The population s concentrated on the Bekasi-Tangerang axis and Bogor-Jakarta axis, reaching the highest values in the central areas of Jakarta city.

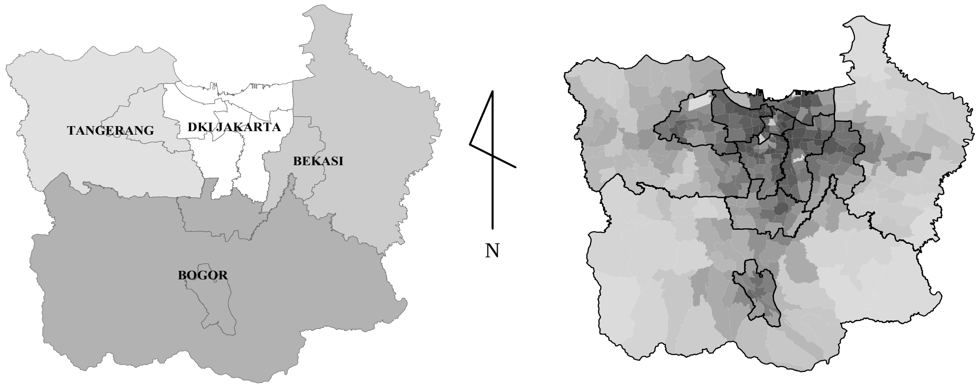


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Figure 3. The Jabotabek Metropolitan Area a. Administrative Boundaries b. Population Density

In the region, the rapid urbanization has been experienced by Tangerang, urbanization in the other areas has remained at moderate levels. The average household size in the area has decreased from 4.7 to 3.8 and the number of households has been increased (Pacific Consultants International ALMEC Corporation, 2003), which point to additional housing need and residential development. On the other hand, economy of the whole area corresponds to 20% of the GDP with the total employed population in Jabotabek is about 7.5 million, concentrated in mainly the center of Jakarta and centers of Bogor, Bekasi and Tangerang.

Report by Pacific Consultants International ALMEC Corporation in 2003 divides the whole Jabotabek metropolitan area into four density groups of residential areas: very low density (20-50 persons/ha), low density (50-100 persons/ha), medium density (100-200 persons/ha) and high density (over 200 persons/ha). Generally low density areas are located far from central Jakarta, and only constitute 5% of the whole Jabotabek area. Urban infrastructure and services are in poor supply conditions in these areas. In low density areas, it is noted in the JICA study that the transit services are supplied in acceptable margins to the residents. In medium density areas, the transportation alternatives increase including paratransit. In high density areas of DKI Jakarta, the traffic congestion is one of the prime problems in the daily urban life, thus mass transit services becomes desirable in these regions.

3. STATED PREFERENCE SURVEY

The number of respondents displays decreasing order with respect to the population of the constituent cities of the Jabotabek metropolitan area (Figure 4).

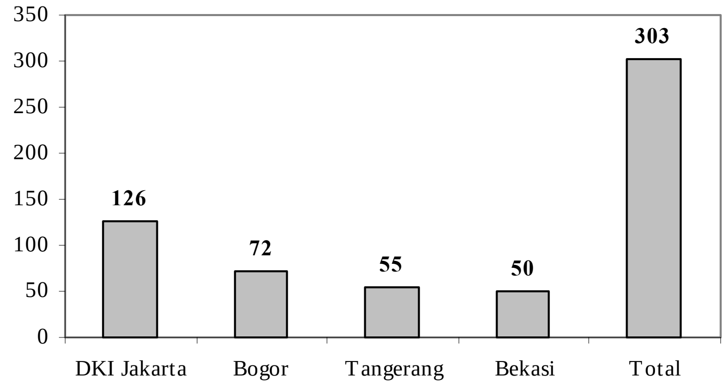

Figure 4 Distribution of Surveyed Households in the Jabotabek Region

The survey consists of two parts: in the first part, households supply information on demographic and socio-economic characteristics as well as attributes of the actual residential area. Attributes of the residential area are referred by distance to activity and transit services. Basically from the responses, it is understood that most of the activity centers and transit services are in close reach from the location of residence in DKI Jakarta (Table 1). Other areas have activity centers or transit services generally far from home location.

Table 1. Distances of Basic Activity Centers and Transit Services from Residential Location

	Distance to supermarket	Distance to restaurant	Distance to park	Distance to department store	Distance to bus stop	Distance to railway station
Depok	2	2	4	4	1	2
Jakarta Barat	1	1	1	2	1	4
Jakarta Pusat	1	1	3	1	1	1
Jakarta Selatan	1	1	2	2	1	3
Jakarta Timur	2	2	3	3	1	4
Jakarta Utara	1	1	1	1	1	2
Kabupaten Bekasi	4	4	4	4	4	4
Kabupaten Bogor	4	3	4	4	4	4
Kabupaten Tangerang	3	1	4	2	1	4
Kota Bekasi	3	2	2	4	4	4
Kota Bogor	4	1	4	2	1	4
Kota Tangerang	1	1	4	4	4	4

1: Less than 500 meters; 2: Between 500 meters and 1 kilometer; 3: Between 1 kilometer and 2 kilometers
4: More than 2 kilometers
Kabupaten: Non-central areas; Kota: central areas

In the second part of the survey, as noted above, households choose one neighborhood, out of three alternatives and commute trip mode out of three alternatives. With respect to the arrangement of the activity centers and transit access points, neighborhoods are named as compact, transit-oriented, or suburban neighborhoods. The commute trip modes are car, bus, and train. This part of the survey is designed in a visual format that displays characteristics of different alternatives such as time and cost of commute to the city center as well as the organization of activity locations and attributes of transportation alternatives for commuter trips around household residences (Appendix to this study provides the basic design of the second part of the survey form in Indonesian).

Neighborhoods that are compact and transit oriented contain all of the activities including the transportation facilities within 2 kilometers; the radius for all of the activities reachable from the home location is assumed to be 3 kilometers radius from the residential location in suburban residential area. Another aspect of neighborhoods is the distance from employment location, i.e., the city center. All together, the characteristics of these residential areas can be summarized as:

i. Transit-Oriented neighborhood (TOD): Public transit stations are near residential locations; residential area is 9~18 kilometers from work locations.
ii. Compact City neighborhood (CC): General urban activity centers are close to residential locations; residential area is 3~9 kilometers from work locations.
iii. Metropolitan suburban neighborhood (MS): Only recreational activity centers are close to residential locations; residential area is 19~30 kilometers from work locations.

In detail, the first alternative, TOD has bus stop and train station within a radius of 500 meters of the home location. In the other alternatives, the train station is within a radius of 1 kilometer in CC and within a radius of 2 kilometers in MS. Commute trip modes are also subject to variation based on the residential area. In fact, each of the commuter trip times and costs changes with respect to the distance from the city center. In terms of travel times and costs, the most expensive neighborhood alternative becomes the MS and the cheapest one becomes TOD.

In the survey form, we ordered three neighborhood alternatives (and commuter modes alternatives nested in residential area alternatives) on one page. So there might be expected some random effects of heterogeneity caused by the ordering of the alternatives on a page. For example, a respondent might be inclined to see the first alternative in a more positive than the second alternative. We control for this type of heterogeneity by reordering three neighborhood alternatives and have respondents make choice again. The responses given by the households support our view that approximately one in four households maintain consistency in all responses, in other words, they choose the same alternative at all of the four times they are presented with the same alternatives in different arrangements.

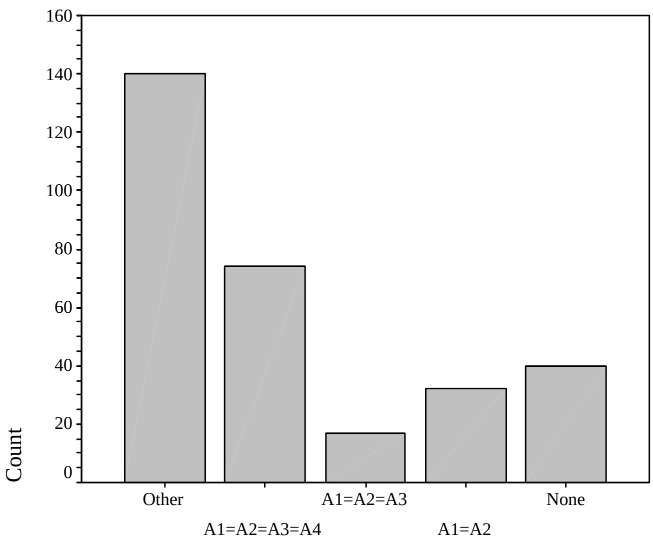

Figure 5. Consistency in Responses (Total = 303)

Information supplied by Figure 5 reveals the lack of consistency in the responses given to different ordering of the alternatives on different occasions. A striking point is that households whose responses do not match from one occasion to another constitute 13%, which should be noted as an opportunity for a further study. This inconsistency in responses might be relevant for capturing both heterogeneity and the response fatigue in the responses, yet the group decision making might also be considered. We will try to locate this by including dummy variables into the choice functions. In sum, respondents have supplied four incidences of choice made among the nine alternatives– a residential area (three alternatives) and a commuter mode (three alternatives nested within residential alternatives).

4. CHOICE MODEL

As the study is based on a stated preference survey, we adopt an approach that normalizes certain attributes of an alternative with the same attributes experienced in real life. These attributes are travel costs, commuter trip duration by car, bus, and train, and distances to activity centers and terminals of transportation modes, i.e., bus stops or railway stations. To normalize these attributes, we have used actual values of household income, maximum commuter trip duration among household members, and distances to activity centers and transit access points. Information on these variables and their descriptive statistics are given in Table 2.

Table 2. Normalized Variables

Normalized Variable	Description	Mean	Std. Deviation
Travel cost	Hypothetical commute trip cost divided by the actual average commute trip costs of working household members	4.30	4.92
Travel time	Hypothetical commute trip time divided by the actual average commute trip time of working household members	80.31	43.42
Distance to Department store	Hypothetical distance to the department store from the residential location divided by the actual distance to the department store	1.01	1.47
Distance to recreation sites	Hypothetical distance to the recreation sites from the residential location divided by the actual distance to the recreational sites	2.52	2.18
Distance to bus stop	Hypothetical distance to the bus stop from the residential location divided by the actual distance to the bus stop	0.55	0.41
Distance to railway station	Hypothetical distance to the railway station from the residential location divided by the actual distance to the railway station	0.69	1.03

Also we have used variables that control for the weekly household travel portfolio of trips made to different activity centers, i.e., work, shopping, and recreation, and the average trip duration to these activity centers. First, we have derived the relative importance of these trips by dividing the number of trips made for these activities with the total number of trips by all household members, and then we use these values to weight the average travel times that household members spend to reach these activities (1). The weighted average travel time inflates the travel time if the relative importance is high. The resultant variables become average travel times weighted with the relative importance of different activities:

$$watt_a = \bar{t}_a / (1 - rel_a) = \bar{t}_a \Big/ \left[1 - \left(n_a \Big/ \sum_A n_A \right) \right] \tag{1}$$

where $watt_a$ refers to the weighted average travel time for activity a (work, shopping or recreation), $\bar{t}_a$ is the actual average travel time for activity a and rel_a refers to the relative importance of the activity a in the activity portfolio, *A* of the household. Note that the relative importance range between zero and one, and the importance attains its highest value at 1. In deriving the *watt*, we have used weekly trips made by households, which is an acceptable time interval for most of the activities to be pursued by households. The descriptive statistics of *rel* and *watt* for various activities are given in Table 3.

By this, we hypothesize that households might prefer to live in residential areas that are close to the activities they frequently pursue. In this study, the variable derived is taken from the real life and carried to the context presented in the hypothetical residential areas. According to Table 3, relative importance for the work activity is the highest as expected and it is followed by shopping and recreation (restaurants) activities in importance.

Table 3. Descriptive Statistics of *rel* and *watt*

	N	Minimum	Maximum	Mean	Std. Deviation
Relative importance of work activity	299	.01	.97	.53	.17
Relative importance of recreation	251	.00	.56	.08	.07
Relative importance of shopping	302	.01	.86	.24	.15
Relaltive importance of recreation (restaurants)	231	.00	.46	.14	.11
Relative importance shopping (department stores)	274	.00	.40	.06	.06
Weighted average travel time to work	302	.00	811.30	64.61	89.12
Weighted average travel time to recreation	302	.00	296.47	33.36	47.66
Weighted average travel time to shopping	302	.21	79.62	9.52	11.03
Weighted average travel time to recreation (restaurants)	302	.00	86.34	13.01	16.25
Weighted average travel time to shopping (department stores)	301	.00	144.83	22.22	20.64

Lastly, we have included the household and residence characteristics into the analysis. The household composition, status of the residence such as owned house or a rent house, residential location dummies for Jakarta, Botabek centers and other areas have been employed. Table 4 gives the descriptive statistics of the household and residence variables.

Table 4. Descriptive Statistics of Household and Residence Characteristics

	N	Minimum	Maximum	Mean	Std. Deviation
# of Household members	303	1	16	5.07	1.93
Residence ownership	303	0	1	.91	.28
# of years in the residence	303	0	79	16.52	13.10
# of homemakers	303	0	4	1.01	.66
# of students	303	0	5	1.36	1.15
# of workers	303	0	7	1.67	.90
Car ownership	303	0	1	.29	.45
Income level #1: below 1 Million[a]	303	0	1	.00	.06
Income level #2: between 1 Million and 2 Millions[a]	303	0	1	.38	.49
Income level #3: between 2 and 3 Millions[a]	303	0	1	.42	.49
Income level #4: between 3 Million and 4.5 Millions[a]	303	0	1	.13	.33
Income level #5: between 4.5 Million and 7 Millions[a]	303	0	1	.06	.23
Income level #6: above 7 Millions[a]	303	0	1	.02	.14
Location of residence: 1: DKI Jakarta, -1: Central Botabek, 0: Other areas	303	-1	1	.16	.81

a. in Indonesian Rupiah.

In the derivation of the choice model, we assume that all modes are assumed to be available to all households in all hypothetical residential areas; thus, all nine alternatives (three as a residential area and three as main commute trip mode) are made available to all households. A typical choice made by the household *h* on alternative *i* at an incidence *t* is formulated as follows:

$$U_{hit} = V_{hit} + \varepsilon_{hit}$$

$$y_{hit} = 1 \Rightarrow \begin{cases} U_{hit} \geq U_{hjt} \\ V_{hit} + \varepsilon_{hit} \geq V_{hjt} + \varepsilon_{hjt} \end{cases}, \forall j \neq i \tag{2}$$

$$V_{hit} = \boldsymbol{\beta}'\mathbf{X}$$

where U, V, and ε are unobserved, observed utilities and the probabilistic error term, respectively. **X** and **β** are vectors of variables and parameters. The formulation given in Eq. 2 leads us to the Multinomial Logit Model (MNL) as given in Eq. 3 (Ben-Akiva and Lerman, 1985). In MNL, the probability of alternative i, by taking the scale parameter of Gumbel distribution equal to one, becomes as follows:

$$P_{MNL}(y_{hit} = 1) = \frac{e^{V_{hit}}}{\sum_{j=1}^{n} e^{V_{hjt}}} \tag{3}$$

An extension of MNL, Random Coeficients Logit Model (RCL) assumes that at least one of the coefficients is random (for a detailed explanation of the RCL model, see Ben Akiva and Lerman, 1985; Train, 1997 and 2003; and McFadden and Train, 2000). In our case, we might assume that one or more of the parameters of the utility function might be random in a way that might reflect heterogeneity n the population and the response fatigue by different order of the alternatives on different survey sheets. In this regard, we used RCL derived from the basic formula given in Eq. 3 by accepting that the parameters are not fixed but rather randomly distributed across the sample. Suppose that parameter β_n is distributed with a probability distribution function, $f(\beta)$. The probability of choosing an alternative, i, is obtained by integrating the distribution of the parameter values:

$$P_{RCL}(y_{hit} = 1) = \int_{\beta_{1h}} \cdots \int_{\beta_{Kh}} \frac{e^{\boldsymbol{\beta}_{\mathbf{h}}\mathbf{X}}}{\sum_{j=1}^{n} e^{\boldsymbol{\beta}_{\mathbf{h}}\mathbf{X}}} f(\beta_{Kh}) \cdots f(\beta_{1h}) d\beta_{Kh} \cdots d\beta_{1h} \tag{4}$$

Further, for each household it might be assumed that that a different set of parameter values might exist. Extension of RCL to locate multiple occasions of choice is straightforward (see Fowles and Wardman, 1988): suppose that a household makes a choice on the same set of alternatives T times, then the probability becomes as follows:

$$P_{mRCL}(y_{hi} = 1) = \int_{\beta_{1h}} \cdots \int_{\beta_{Kh}} \left[\prod_{t=1}^{T} \frac{e^{\boldsymbol{\beta}_{\mathbf{h}}\mathbf{X}}}{\sum_{j=1}^{n} e^{\boldsymbol{\beta}_{\mathbf{h}}\mathbf{X}}} \right] f(\beta_{Kh}) \cdots f(\beta_{1h}) d\beta_{Kh} \cdots d\beta \tag{5}$$

5. ESTIMATION RESULTS

Using the probabilities derived in the previous section, we have the likelihood functions of two different models as follows:

$$U_i \geq U_j, \forall i \neq j \Rightarrow \begin{cases} \ell_{RCL} = \prod_{h=1}^{4H}\left[P_{RCL} \prod_j (1 - P_{RCL}) \right] \\ \ell_{mRCL} = \prod_{h=1}^{H}\left[P_{mRCL} \prod_j (1 - P_{mRCL}) \right] \end{cases}$$

where H stands the number of the households recruited in the survey.

An important point in the estimation process is the identification issue. It is well known that in the discrete choice models, the absolute values of attributes do not matter, but the differences between these attributes do. For this reason, we have assumed the attributes of MS-RAIL combination as the benchmark in both models, and take the differences between attributes of other alternatives from this alternative for all of the alternatives.

Table 5. Model Estimation Results

Variable		*RCL*		*mRCL*	
CC= Compact City; TOD= Transit Oriented Development; MS= Metropolitan Suburban Development		Coefficient Value	t-value	Coefficient Value	t-value
Normalized variables	Travel Cost	-0.13	-3.21	-0.41	-7.52
	Travel Time	-0.02	-2.42	0.00	-0.89
	Distance to market and department store	-0.18	-1.02	-0.09	-0.97
	Distance to recreation sites	-0.13	-2.13	-0.31	-3.78
	Distance to bus stop	-0.36	0.00	0.42	0.00
	Distance to rail station	-0.27	-0.09	-0.28	-3.05
Household trip portfolio for CC-CAR	Weighted average travel time to work	-0.84	-5.32	-1.01	-3.21
	Weighted average travel time to recreation	-0.02	-2.14	0.00	-2.00
	Weighted average travel time to shopping	-0.23	-2.41	-0.10	-1.85
	Weighted average travel time to recreation (restaurants)	0.00	-3.15	0.01	-2.71
	Weighted average travel time to shopping (department stores)	-0.07	-0.91	0.00	-0.52
Household characteristics for CC-CAR	# of Household members	0.04	1.00	0.07	1.85
	Residence ownership	0.00	1.76	0.01	2.01
	# of homemakers	0.00	0.97	0.24	0.25
	Car ownership	0.01	2.04	0.09	1.99
	Location of residence: 1: DKI Jakarta, -1: Central Botabek, 0: Other areas	0.00	1.84	-0.01	-1.81
Alternative specific constants	CC-CAR	0.24	1.21	0.94	4.35
	CC-BUS	0.41	2.54	0.32	1.04
	CC-RAIL	-0.08	-0.54	-0.74	-5.71
	TOD-CAR	-0.09	-0.67	0.23	0.84
	TOD-BUS	-0.07	0.00	-1.32	-6.25
	TOD-RAIL	0.02	0.65	-1.24	-6.28
	MS-CAR	0.61	1.94	-0.07	-0.28
	MS-BUS	0.51	2.32	-0.04	-0.45
	MS-RAIL	• • • • • • • • **reference**		• • • • • • • •	
	Standard Deviation for travel cost	0.21	3.54	0.54	7.98
	Standard Deviation for travel time	0.01	2.54	0.03	11.32
	Standard Deviation for distance to markets	0.21	0.98	0.21	1.65
	Standard Deviation for distance to recreation sites	0.18	0.66	0.40	4.12
Log Likelihood Functions	no coefficients	-2663.04			
	constants only	-2472.22			
	model likelihood	-1851.21		-499.79	
	degrees of fredom	16		16	
Sample Size		1212		303	

Both of the models display significant improvements over the model with no coefficients (Table 5). mRCL, which locates the multiple responses performs better than the RCL model, which does not consider the multiple responses. In both the RCL and mRCL models, random coefficients are assumed to exist for travel cost, travel time, distance to shopping and recreation activity sites, perception of which can easily affect the choices made. Therefore, we assume coefficients to these variables as random and also estimate their standard deviations assumed to be IID Normal with the true parameter value as the mean. The results of the RCL model suggest that distance to a rail station is an important determinant of choice, such that as distance increases the propensity to live in any of the alternative environments decreases. In both the CC and TOD, rail stations and bus stops are at closer locations than in the MS.

Note that the coefficient values reported for both household trip portfolio and household characteristics contain double information: firstly, in order to estimate the utility function the coefficient values represent subtracted values from MS-RAIL, and secondly, in order to report the results in a meaningful way, we take the values reported deviations of coefficient value of CC-CAR alternative with respect to other variables. Similar to normalized variables, the household trip portfolio variables have signs negative too. As reported in the previous section, the trip times are exaggerated or inflated with respect to the relative importance to the household, thus the work activity constitutes the highest importance when compared to the other variables such as recreation activity. Contrary to the previous groups of variables, household characteristics increase the propensity to select the compact residential areas and the car. This is a bit contradictory in itself as it is expected that the in compact areas, the need to use cars reduce. The model does not reveal significant result(s) for the location dummy used for identifying households living in DKI Jakarta, in central Botabek and other areas in the metropolitan area. Alternative specific constants reveal results that in RCL, MS-CAR is seen to be the most preferred alternative, but this changes to CC-CAR in mRCL.

6. DISCUSSION

Three residential area development alternatives, which are compact, transit-oriented and suburban are assessed in the eye of the Jabotabek Metropolitan Area households by using SP survey technology, new variables and utility model that remedies the response fatigue, heterogeneity by allowing random coefficients in the utility model. The alternative specific residential and commute trip mode characteristics in the SP survey are normalized with their real life counterparts, the variables produced by this method are named as normalized variables. This method maps the characteristics of the alternatives in the SP design to a scale that can be referred from everyday life. But another important issue has been detected when the households are presented with the same alternatives in different orderings in other parts of the survey form: only one in four households maintain the response consistency across different alternative orderings. This might be coupled as a response fatigue and needs further refinement in order to be included into the models. The model that we have used is the Random Coefficients Logit (RCL) which allows existence of the random errors to the coefficients. This remedies the IIA inefficiency of the traditional Multinomial Logit model and increases the ability to locate elicitation of more flexible models. Also the model we have estimated has ruled out the household heterogeneity by locating four occasions of household responses on the same alternatives.

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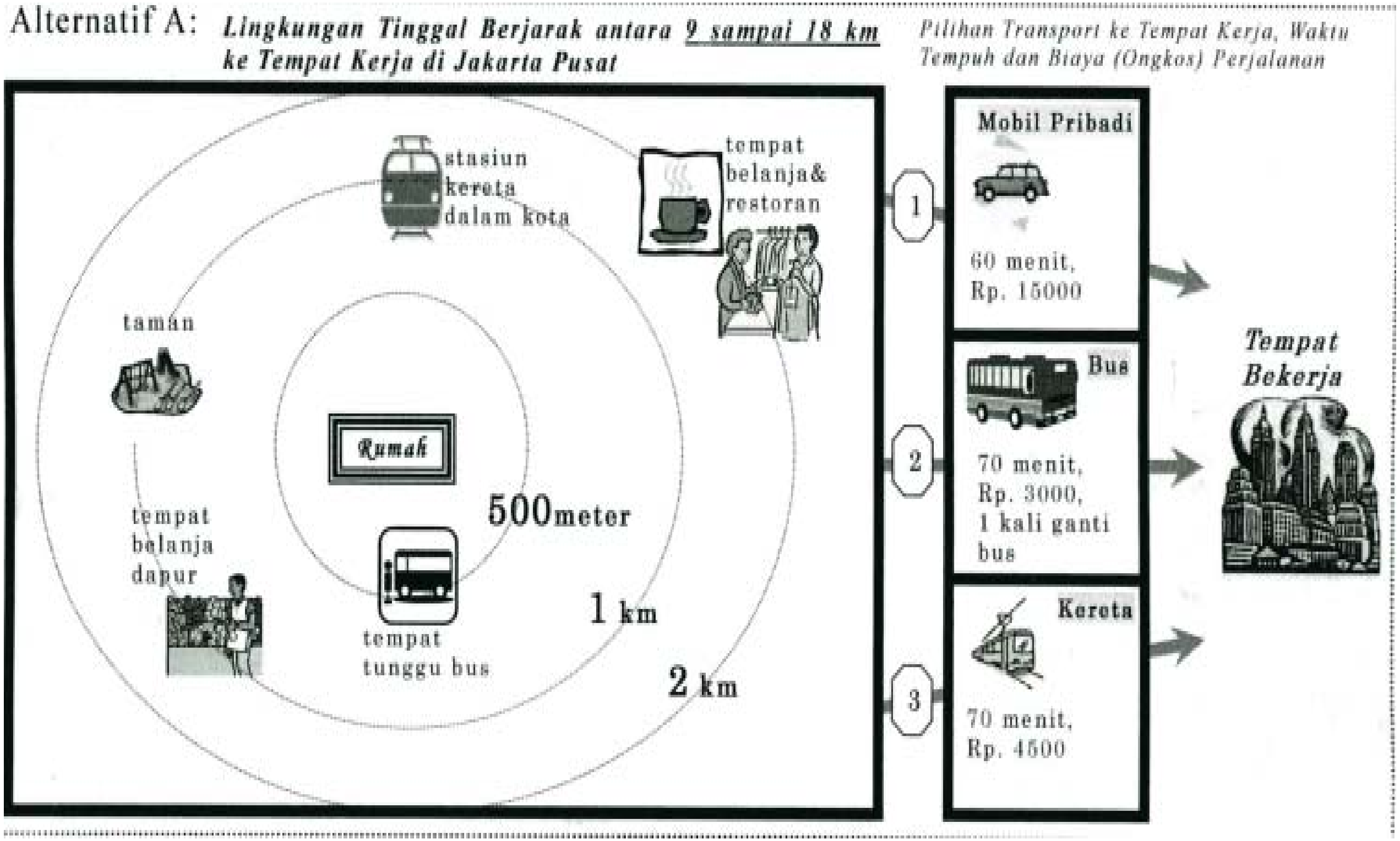
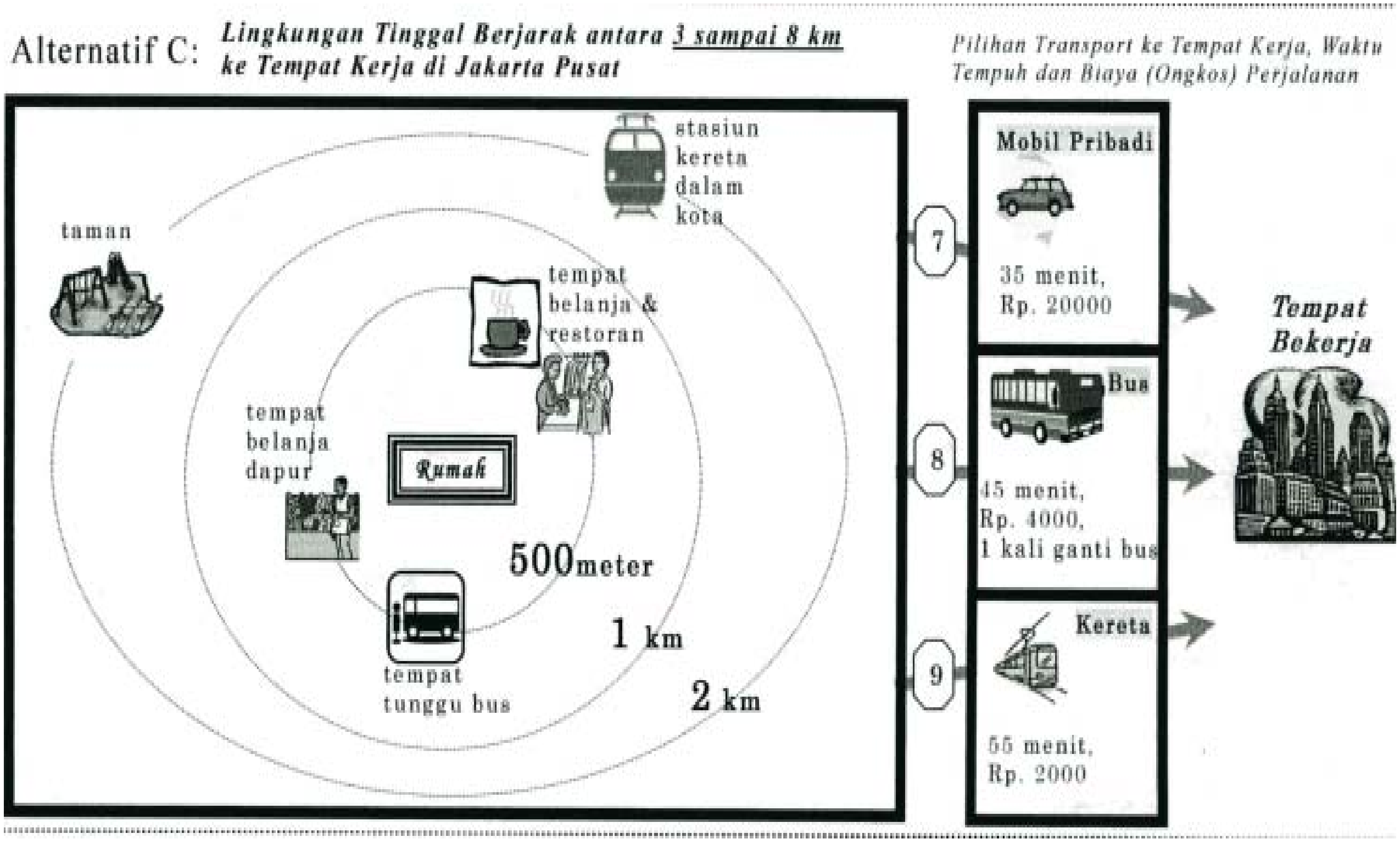
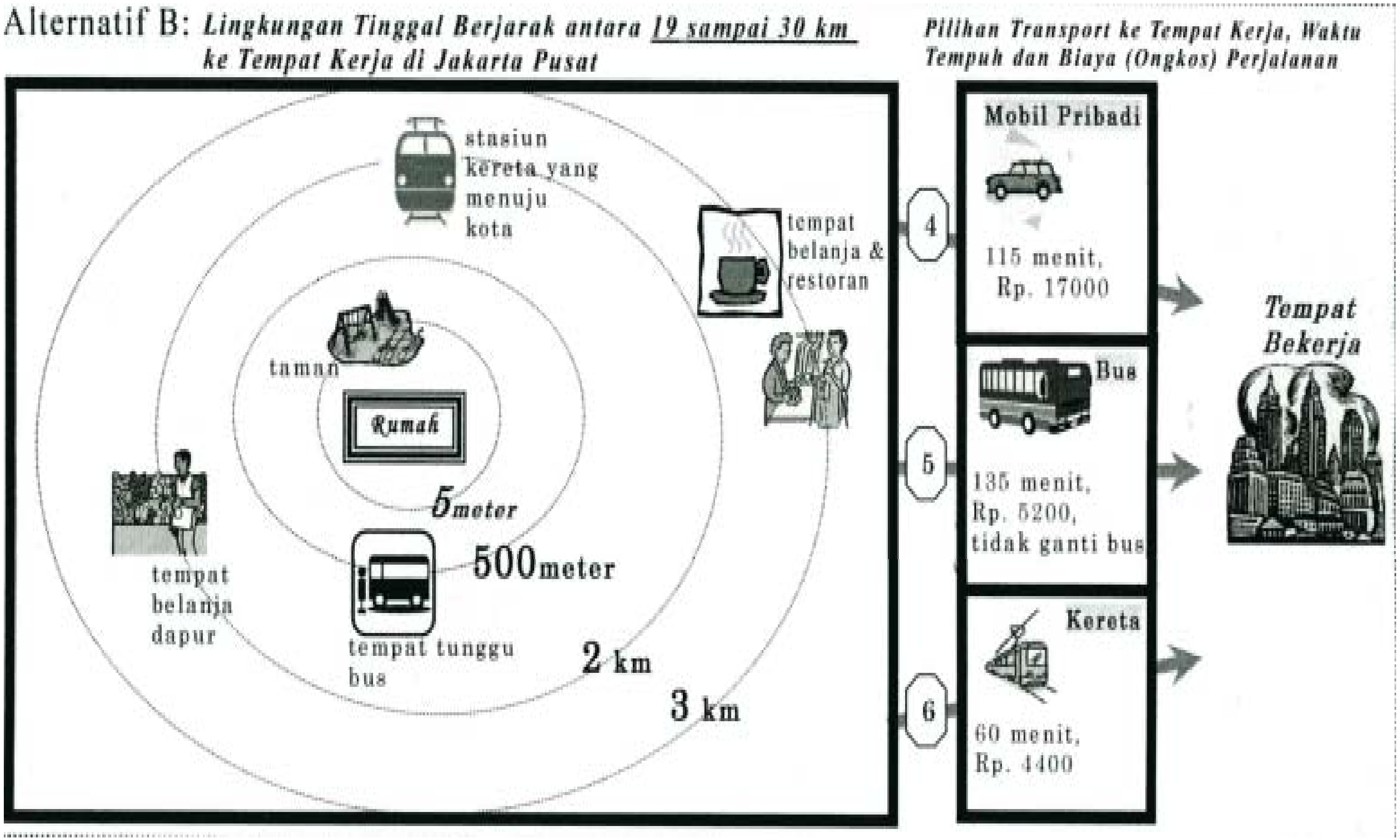
APPENDIX

The alternatives, A (TOD) to C (MS) of residential locations and the commute trip mode presented to the surveyed households.





Alternatif C:
Lingkungan Tinggal Berjarak antara 3 sampai 8 km ke Tempat Kerja di Jakarta Pusat
Pilihan Transport ke Tempat Kerja, Waktu Tempuh dan Biaya (Ongkos) Perjalanan
stasiun kereta dalam kota
taman
tempat belanja & restoran
tempat belanja dapur
Rumah
500meter
1 km
2 km
tempat tunggu bus
7
Mobil Pribadi
35 menit, Rp. 20000
8
Bus
45 menit, Rp. 4000, 1 kali ganti bus
9
Kereta
55 menit, Rp. 2000
Tempat Bekerja


Alternatif B: Lingkungan Tinggal Berjarak antara 19 sampai 30 km ke Tempat Kerja di Jakarta Pusat
Pilihan Transport ke Tempat Kerja, Waktu Tempuh dan Biaya (Ongkos) Perjalanan
stasiun kereta yang menuju kota
tempat belanja & restoran
taman
Rumah
5meter
500meter
tempat belanja dapur
tempat tunggu bus
2 km
3 km
4
5
6
Mobil Pribadi
115 menit,
Rp. 17000
Bus
135 menit,
Rp. 5200,
tidak ganti bus
Kereta
60 menit,
Rp. 4400
Tempat Bekerja