Journal of Transportation Science Society of Malaysia 1 (2005)
101-109

Social Impact Assessment of Transportation Projects by Benefit or Damage Cost Analysis

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ABSTRACT

Benefit/damage cost analysis is one of the alternative tools considered in the Trans-Simpact 2000 for Klang Valley. It is derived from the project evaluation technique that measures the benefit or damage cost of a project. The study involves with the formulation of the benefit or damage cost analysis model for SIA from two selected utility functions namely linear and CES. The CES utility function is found to be the best form to measure noise impact from an airport project in Osaka, Japan. The application of the utility function however, will require the calibration by the linear utility function.

Keywords: Benefit or damage cost analysis, noise impact, project evaluation, social impact assessment, transportation projects, utility functions.

INTRODUCTION

Benefit or damage cost analysis is one of the alternative tools considered in the Study for Social Impact Assessment (SIA) of Selected Transportation Projects to Affected Communities in the Klang Valley (Trans-Simpact 2000). This study is an attempt to conduct social impact assessment of a transportation project by the benefit or damage cost analysis. The basis of the approach is derived from project evaluation technique for assessment of the cost and benefit of a project. Benefit is defined as the positive impacts to a certain individuals and the cost is the negative impacts (economically termed as the damage cost) to the other individuals as the consequences of implementing the project. Preliminary assessment of the overall transportation condition of the study area is based on visual observation and Focus Group Discussion (FGD) data. The detail study that involve with the formulation of the benefit or damage cost analysis model for SIA by the application of the main data source collected for the study. The preliminary analysis is undertaken mainly to gain better understanding about the transportation condition of the study sites and then to identify the variables associated with SIA. The results of the preliminary analysis indicate that, the transportation condition of the study site can be ranked from fair to good with sites closed to the highway project ranked high in term of receiving the most impacts from the implementation of the projects. The traffic and transportation review of the site condition prior and after the project is no doubt will provide the study the preliminary assessment. The actual measurement of the social impact of the transportation project however, cannot be distinguished from the traffic and environmental impacts. SIA by benefit or damage cost analysis is undertaken as to provide more precise measurement of social impacts.

DETAILED ANALYSIS USING UTILITY FUNCTION

This analysis is theoretically developed from the utility level that can be defined as the level of the quality of life or the welfare status that the specific group of people would like to maintain (Adnan Zulkiple 1990). It should be able to accommodate the three different economic viewpoints, namely, efficiency, equity and stability. The change in the individual utility level is the measurement of the social impact of the individual and the summation of the change for all individuals in the society are the measurement of the social cost or benefit of the society. Social impact analysis on social quality change is conducted by observing how the utility level of the individual varies with changes of the qualitative and non-qualitative variables (Morisugi et al. 1985). The benefit from the change of utility function before project, V_i and after project, V_a is valued by the monetary equivalent of the difference between the two utility functions. If the difference is positive, then the social impact brings benefit to the community, while if the difference is negative, then the social impact cause damage to the community.

Morisugi et al. 1986, in a study on the forms of utility function for residential behaviour analysis and neighbourhood benefits estimation in Osaka, Japan had short-listed four types of utility functions, namely as follows:

- Linear: The simplest form of utility function. The utility model can easily be formulated and calibrated. However, it might not provide fair distribution of the value of the parameters across the model.
- Log-linear: Deriving utility model from this utility function is more complicated than the linear models. It offers almost similar characteristics as of linear models.
- CES: This utility function is also as complicated as of the log-linear utility function. However, it offers the formulation and calibration of a fair distribution of the value of the parameters across the model.
- VES: Similar characteristics as of CES but more complicated than the former.

The study discovered that that the CES utility's function is the best form of utility function for the formulation and calibration of consistent combined utility model for measurement of social impacts and quantification of benefits and damage cost. The application of the utility function however, will require the formulation of the model derived from the linear utility function as well for calibration of the models. Since, the CES utility function is complicated, the desired utility model might not be able to be calibrated without comprehensive modelling, and therefore in this paper the linear model is developed as the starting point. The linear utility model is expressed as follows (Morisugi et al. 1986):

$$\alpha V = \alpha(I+r-R) + \beta_1 X_1 + \beta_2(150 - t) + \beta_3 X_2 + \beta_4(5-X_3) + \gamma(120 - Q) \quad (1)$$

where

I is the annual income (RM)
r is the yearly equivalent price of the household's other house (RM)
R is the yearly equivalent price of the resident (RM)
t is the commuting time (in minutes)
X_1 is the housing size (sq.m)
X_2 is the duration of sun exposure (hours per day)
X_3 is the quality of the highway service (1: good or 2: poor)
Q is the social indicator (%) and
α, β_1, β_2, β_3, β_4 and γ are the parameters

This linear model is suitable for application at the selected study area since reasonable results can be obtained provided appropriate data is collected for the study area.

DATA REQUIREMENT

The source of the data is from the primary data collection for the study for the selected six sites in the Klang Valley conducted by the main consultant, Jurutera Perunding Zaaba Sdn. Bhd. as shown in Table 1. From more than 2000 data samples, 147 have been randomly selected as data samples for the modeling purposes as below:

TABLE 1. Size and characteristics of data samples for determination of parameters of the utility model

Sites	Distance from railway/highway		Type of house	Length of stay (years)
	Location	No. of samples		
PUTRA LRT Taman Melati	Near	3	Flat (43%); Terrace (43%) & House (14%)	3 to 16
	Middle	12		
	Far	6		
	Total	21		
	Near	19	Squatters (14%); Flat	

MRRII Taman Permata	Middle	2	(36%); Terrace (23%); House (14%) & Bungalow (13%)	1 to 45
	Far	1		
	Total	22		
MRRII, KTM Commuter & STAR LRT Bandar Tasik Selatan	Near	11	Flat (67%) & Terrace (23%)	0.5 to 6
	Middle	7		
	Far	6		
	Total	24		
KESAS Kinrara Area	Near	19	Squatters (21%); Flat (12%) & Terrace (67%)	1 to 27
	Middle	0		
	Far	5		
	Total	24		
LDP Puchong Spur	Near	22	Squatters (54%); Flat (7%); Terrace (11%) & Bungalow (28%)	0.5 to 30
	Middle	6		
	Far	0		
	Total	28		
LDP Kelana Jaya	Near	26	Terrace (93%) & Bungalow (7%)	2 to 22
	Middle	2		
	Far	0		
	Total	28		
Total Data Samples	Near	100	Squatters (16%); Flat (26%); Terrace (50%) & Bungalow (8%)	0.5 to 45
	Middle	29		
	Far	18		
	Total	147		

Sources: Trans-Simpact 2000
Notes: Distance from railway/highway: Near < 50 m; Middle from 50 m to 100 m & Far > 100 m

Only the relevant questions and information as of the following are analyzed. Description of the relevant data and information is provided in Table 2.

TABLE 2. Description of relevant data and information

No	Main Topic	Questions & Information
1	ID of the Data	Name of the Highway, the Housing Area and Distance from the Highway
2	Self Mobilization	Travel Mode and the use of public transport after the project
3	Change in Travel Time And Cost	The use of public transport before the project and Commuting Time (2-ways)
4	House Relocation & Demolition	Yes or No
5	Social & Psychological Impacts	All 36 questions for mass transit and All 41 questions for Highway

6	Compensation	Yes or No and if Yes, specify the amount?
7	Possibility of Moving Out	Yes or No
8	Socioeconomic & Demographic	Job: Government or Private, House Price or Rental Cost, Length of Stay, Type of House and Monthly income

Sources: Trans-Simpact 2000

Variables X_3 and t in equation 1 explain about mobilisation and change in travel time and cost respectively of the sample. X_3 is based on the choice between good and poor public transport service before and after the project ($X_3 = 1$ if the service is good and 2 otherwise). t is simply the commuting time to work for both ways in minutes. Relocation and type of houses are explained by X_1, the house area size and X_2, the exposure to sunny time or availability of open space. X_1 is the size of the housing area before and after the project that is assumed to be as the factor of one fourth of the income. X_2 is simply the assignment of values of 12 hours for all types of housing except for squatters that is considered to have 50 percent of the open space of the other types. Socio-economic and housing attributes are represented by R, the annual housing cost and I, the annual income of the household and the spouse. If the household owns the house, R, the annual housing cost is derived from the following formula:

$$R = \text{House Price} \times (1 + \text{interest rate} \times 30 \text{ years}) / 30 \text{ years} \qquad (2)$$

If the house is on rented premise, R, the annual housing rent is calculated by the following formula:

$$R = \text{Rental Cost} \times 12 \text{ months} \qquad (3)$$

Social and psychological impacts such that the social quality index, Q is derived based on the percentage number of the negative responses of the social and psychological questions of the survey.

DETERMINATION OF THE PARAMETERS

The parameters of the utility model are determined by regression analysis of 147 randomly selected data samples from the database for all sites. The application of the linear multiple regression will require database for the following variables.

For data sample i =1 to n and j =1 to n

- I_i is the annual income in RM 1,000,
- r_j is the yearly equivalent price of the household's other house in RM 1,000,
- R_i is the yearly equivalent price of household currently resides house in RM 1,000,

t_i is the commuting time in minutes,
X_{1i} is the housing size in m^2,
X_{2i} is the duration of sun exposure in hours per day,
X_{3i} is the quality of the highway service (1: good or 2: poor),
Q_i is the social indicator (%), and
V_i, the utility level that is in the form E_i / α where E_i is the amount of benefit or compensation (in RM) and α is the conversion factor.

A small sample size, such that n = 20 is adequate for the determination of the parameters. Based on the 147 data samples, the parameters of the utility model have been estimated to be as follows:

$$\alpha = 0.2169;\ \beta_1 = 0.0116;\ \beta_2 = 0.0006;\ \beta_3 = -0.0063;\ \beta_4 = -0.0195\ \&\ \gamma = 0.0005 \quad (4)$$

Now, the utility model can now be expressed as follows:

$$V = (0.2169(I+r-R)+0.0116X_1+0.0006(150–t)–0.0063X_2–0.0195(5-X_3)+ 0.0005(120 – Q))/0.2169 \quad (5)$$

where, I, r and R is in the unit of RM 1,000

SUMMARY OF THE RESULT

In short, the benefit or damage cost analysis by the linear utility modeling can be summarised as follows:

Step 1: Derivation of the Utility Model.
Step 2: Data Collection, Conversion and Interpretation.
Step 3: Measurement of the Utility Level "After" and "Before" the Project.
Step 4: Measurement of the Utility Level "After" and "Before" the Project.
Step 5: Assessment of the Relevant Impacts.
Step 6: Quantification of the Benefit or Damage Cost.

As defined, good impacts means benefit while bad impacts means damage cost. The analysis of the results will be on the observation on how the change in the condition of the variables “after and before the project” produces impact to the utility level. The list the assumptions and interpretation of the results are as follows:

- Income is constant.
- Change in the price or rent of current house can cause adverse impacts since the weightage of the parameter is the highest. The more negative the impacts the better is the expenditure of the

household since the household is enjoying lower monthly payment or rent of the house.

- Change in the house size is second most significance. The positive impact indicates that at least 1 household has moved to a house with larger housing area. The negative impact means, the housing area is getting smaller from the condition prior to the implementation of the project.
- For the commuting time, negative impact is desirable since this indicates that the commuting time of the household is reduced due to the implementation of the project. The positive impacts mean that the affected households are spending more time to commute to work everyday.
- For the exposure to daylight, positive impact is desirable since the household is now living at a better location and with more open space.
- Positive change in the public transport service quality is desirable since it indicates that the household is enjoying a better public transport service due to the provision of mass transit. Sites with the highway project only are not affected by this variable except for MRRII along Taman Permata with a positive impact.
- Change in the social quality index for all study sites is negative. This indicates that the communities are suffering from the social problem due to the provision of the railway and or highway projects.

The result of the benefit/damage cost analysis by the outlined procedure for the six selected sites in Klang Valley is presented in Tables 3 and 4.

TABLE 3. Estimated utility level "after the project"

Study sites	Sampling size	After (RM/Year)			
		Maximum	Minimum	Average	Total
Putra LRT: Taman Melati	21	44,159	17,247	25,510	535,704
MRRII: Taman Permata	22	111,157	8,665	43,451	955,932
KTM Commuter: Bandar Tasik Selatan	24	95,822	5,871	30,701	736,829
KESAS: Kinrara	24	92,269	10,667	35,466	851,181
LDP: Puchong Spur	28	47,882	8,294	21,119	591,318
LDP: Kelana Jaya	28	107,730	14,659	38,435	1,076,185
Overall for study area	147	111,157	5,871	32,294	4,747,149

Source: Trans-Simpact 2000

TABLE 4. Estimated utility level "before the project"

Study sites	Sampling size	Before (RM/Year)			
		Maximum	Minimum	Average	Total
Putra LRT: Taman Melati	21	44,337	17,512	25,627	538,165
MRRII: Taman Permata	22	111,167	8,665	43,522	957,479
KTM Commuter: Bandar Tasik Selatan	24	95,912	7,103	30,932	742,367
KESAS: Kinrara	24	92,365	10,686	36,057	865,366
LDP: Puchong Spur	28	47,943	8,425	19,106	534,966
LDP: Kelana Jaya	28	107,827	14,549	38,553	1,079,471
Overall for Study area	147	111,167	7,103	32,094	4,717,814

Source: Trans-Simpact 2000

It is recommended that compensation to be paid to those with negative utility change. However, the social impact assessment by the benefit or damage cost analysis discovers that there is no need to compensate the communities since all the study sites are actually enjoying benefits from the provision of transportation facilities as presented in Table 5.

TABLE 5. Benefit or damage cost and social benefit or social cost

Study sites	Sample size	Benefit or damage cost (RM/Year)				Social benefit or social cost (RM/Year)	Compensation per husehold (RM/Year)
		Max	Min	Ave	Total		
Putra LRT	21	457	-248	117	2,461	2,461	Not required
MRRII	22	178	-21	70	1,547	1,547	Not required
KTM Commuter	24	1,408	-100	231	5,538	5,538	Not required
KESAS	24	9,699	-166	591	14,184	14,184	Not required
LDP site 1	28	131	-94	14	386	386	Not required
LDP site 2	28	273	-111	117	3,286	3,286	Not required
Overall	147	9,699	-248	200	29,336	29,33	Not required

Source: Trans-Simpact 2000

Notes:

1. Social cost or social benefit is the aggregate of benefit or damage cost for the study sites.

2. Average compensation per household is zero if the social cost or social benefit is positive.

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