# Estimation of Trip Generation from Residential Area in Bangkok

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Matt SRINARAWAT[1],Yuta ITO[2], Atsushi FUKUDA[3], Mikiharu ARIMURA[4]

[1] Graduate School of Science & Technology
Nihon University 739C 7-24-1 Narashinodai, Funabashi, Chiba 247-8501 Japan
Tel/Fax 047-469-5355,
E-mail address: mattcadalic@hotmail.com

[2] Graduate School of Science & Technology
Nihon University, 739C 7-24-1 Narashinodai, Funabashi, Chiba 247-8501 Japan,
Tel/Fax 047-469-5355,
E-mail address: ice3m-br406@hotmail.co.jp

[3] Department of Transport Engineering & Socio-technology, College of Science & Technology,
Nihon University 739C 7-24-1 Narashinodai, Funabashi, Chiba 247-8501 Japan,
Tel/Fax 047-469-5355,
E-mail address: fukuda.atsushi@nihon-u.ac.jp

[4] Department of Transport Engineering & Socio-technology, College of Science & Technology,
Nihon University 739C 7-24-1 Narashinodai, Funabashi, Chiba 247-8501 Japan,
Tel/Fax 047-469-5355,
E-mail address: arimura.mikiharu@nihon-u.ac.jp

## Abstract

Most of the developments of residential quarters in Bangkok carried out in the sub-street branching off a major street called "Soi". Since Bangkok is located on lowland area, in order to prevent flood, there are many open spaces used to impound water. Consequently, residential quarters were developed between these open spaces. However, according to the recent urbanization, the reserved open spaces were also being developed into residential quarter. The traffic generated from those areas has increased beyond the capacity of Soi and caused traffic congestion in the main road. The estimation of generated traffic volume from Soi is vital in order to find the solution for traffic congestion. But in the present state, there is not enough statistic data on the traffic generation from household. Therefore the aim of this study is to find the new generated traffic estimation method that does not require statistic data.

**Keywords:** Traffic volume, Trip generation, Traffic jam, Trip estimation, Generated Trip base, Traffic Estimation model

## 1. Introduction

Most of the developments of residential quarters in Bangkok carried out in sub street called "Soi". These streets are all connected to the main road, but in most cases, do not act as a thoroughfare to support Bangkok's road network.

Since Bangkok is located on lowland area and lies only about two meters above sea level, in order to prevent flood, open spaces to impound water was required. The development of residential quarters have been scattered by these open spaces. According to the recent urbanization, even the open spaces reserved for water impound were being developed into residential quarter. The traffic generated from such area has increased beyond the capacity of Soi and became the main cause of traffic congestion in Bangkok's road.

To be able to understand this problem more clearly in order to find the solution for traffic congestion on the main road, the estimation of generated traffic volume from Soi is essential.

However, in the present state, there is not enough statistic data on population, household and vehicle possession, etc., also there are not enough

surveys related to this topic conducted in Thailand. It is difficult to estimate the generated traffic volume in this state.

Based on the problem stated above, the objective is to construct a mathematic model which is capable of estimating traffics generated from Soi. This was done by conducting household survey to acquire the generated trip base data, and by using satellite images to verify the number of each household type. After the calculation is done the generation trip estimation was compared with actual generation trip data acquired from traffic survey at Soi entrances to verify the result.

## 2. Methodology of this study

In this study, based on form of the house, houses in Thailand are classified into three types which are Single house, Condominium and Shop house. Single houses in Thailand are one-storied houses or two stories made out of concrete, and in many cases, the parking lot is included within the house which allow a parking of one to two cars. The condominium is the housing complex like an apartment in most cities. The building can be from 3 stories high to 20 stories or more and in most case, the parking lot are provided at the ground floor of the building. The shop house is three to four storied houses build in a row with each house sharing side walls, the first floor of the house is usually made into a store, with the upper floors being used as a living quarters.

In this study, firstly the houses are classified into three types: single house, condominium and shop house based on the form of each houses as shown in Fig. 1, Fig. 2 and Fig. 3.

**Fig. 1** Single house

**Fig. 2** Condominium

**Fig. 3** Shop house

Because it was assumed that the household's composition, number of vehicle in possession, etc. are different according to each house type, the generated trip base from each house type is likely be different as well. Thus the household questionnaire and the generated trip base calculation were done according to different house type.

The number of households in Soi was counted by the satellite images. Single house was counted as one household by one unit. For condominium and shop house, the area of the building is then divided by the average lot area of one floor. For condominium, after divided by average lot area, the household number is then multiplied by number of building's floor.

The generated traffic volume from each house type in Soi was estimated by multiplying the generated trip base from each house type with the households' number of each house type.

## 3. Execution of questionnaire survey

The generation trips from each house type and information on the average household's composition, number of resident, individual attribute, Soi's transportation, etc. were collected through the questionnaire survey.

To obtain the Generated Trip Base from each house type, home visit questionnaire survey was done. When the residential district is selected, the area with Soi of various scales is chosen. Four Sois connected to Lat Prao road is where the survey was done. It is specific that an existing research on the para-transit and Soi will be done accordingly in the Lat Prao area, as shown in the map in Fig.4 below. The Questionnaire related to condominium was conducted in three Soi except Lat Prao 62 since no condominium exist in Soi 62.

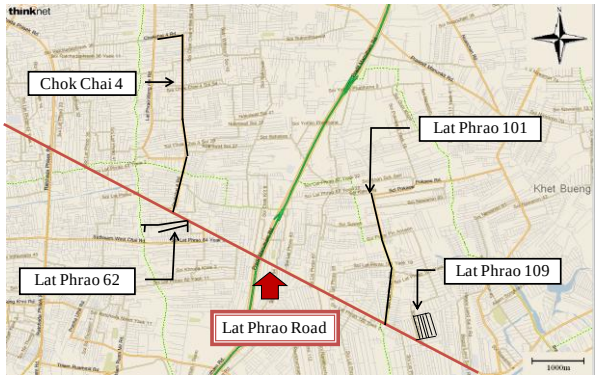


**Fig. 4** Sois where the investigation was conducted

The questionnaire survey is composed of questions related to the whole household and questions related to each Individual residing person. The number of owned vehicles of the whole household are separated into the number of owned cars and the numbers of owned motorcycles. Transportation modes used, the trip purpose, age, gender, occupation, the income and the possesion of driving license were included in the individual investigation part of the questionnaire.

All the questionnaires done in each Soi are then analyzed. The generation trip base from each Soi according to the house type was calculated from result of the questionnaire survey shown in table-1, table-2 and table-3.

**Table-1** Single house generated trip base

Object： 4 Sois、88Household

| Transportation | Generated Trip Base (Trips/Household) | Standard Deviation (Trips/Household) |
|---|---|---|
| Walk | 0.63 | 0.14 |
| Motorcycle | 0.34 | 0.25 |
| Car | 1.10 | 0.41 |
| Para-Transit | 0.17 | 0.19 |
| Total | 2.25 | 0.33 |

**Table-2** Condominium generated trip base

Object： 3 Sois、91Household

| Transportation | Generated Trip Base (Trips/Household) | Standard Deviation (Trips/Household) |
|---|---|---|
| Walk | 0.34 | 0.30 |
| Motorcycle | 0.38 | 0.22 |
| Car | 0.28 | 0.17 |
| Para-Transit | 0.62 | 0.57 |
| Total | 1.61 | 0.15 |

**Table-3** Shop house generated trip base

Object： 4 Sois、107House Hold

| Transportation | Generated Trip Base (Trips/Household) | Standard Deviation (Trips/Household) |
|---|---|---|
| Walk | 0.49 | 0.36 |
| Motorcycle | 0.37 | 0.07 |
| Car | 0.61 | 0.17 |
| Para-Transit | 0.19 | 0.18 |
| Total | 1.66 | 0.31 |

## 4. Generated trip estimation model

The generated traffic came out from Soi during the two hours of the morning peak was estimated by using the following mathematic expressions.

$$y = \beta \sum_{i=1}^{3} a_i x_i \quad (1)$$

Here,

$y$ : Generated traffic volume at Soi's exit during the peak of two hours in morning (trip)

$\beta$ : Peak rate during the peak of two hours in morning

$a_i$ : Generated Trip Base according to house type (Trip / Household)

$x_i$ : Number of household according to house type (household)

$i$ : 1 = Single house 2 = Condominium 3 = Shop house

The generated trip base calculated from the questionnaire survey is a generated trip base of one day period. In this study, the traffic volume estimated by the model is a generated traffic volume during the peak of two hours in the morning. Therefore, the generated trip is multiplied by $\beta$ the peak rate of two hours traffic of the morning peak.

The reason for this is, for model verification, it is impossible in this state to measure the actual traffic volume generated from each Soi for one day period. Only two hours of traffic survey can be done. The peak rate $\beta$ was calculated by dividing the number of generated traffic during the

two hours peak of each Soi by the number of generated traffic during one day period of the same Soi acquired from questionnaire survey. The average peak rate value of $\beta$ = 0.63 is the averaged peak from all Sois. The peak rate from each Soi is shown in table-4 below. It is assumed that 63% of the total traffic generated in one day was generated during the peak period of two hours in the morning.

**Table-4** Peak rate of each Soi

| Soi Number | Peak Rate | Average | Standard Deviation |
|---|---|---|---|
| Lat Phrao 63 | 0.62 | 0.63 | 0.08 |
| Lat Phrao 67/2 | 0.47 | | |
| Lat Phrao 69 | 0.67 | | |
| Lat Phrao 80/3 | 0.69 | | |
| Lat Phrao 91 | 0.70 | | |

In this study, the number of households for each house type $x_i$ located in Soi was counted up by using the satellite images. Single house was counted as one household by one unit. For condominium and shop house, first the unit was identified from the satellite images, then after that the area of the building is then divided by the average lot area of one floor calculated from images taken outside the building. For condominium, after divided by average lot area, the household number is then multiplied by number of building's floor. In the next table-5, Number of sampled building and average lot area are shown.

**Table-5** Average lot area and sample size

| House Type | Average Lot Area ($m^2$) | Sample (Buildings) | Standard Deviation ( $m^2$ ) |
|---|---|---|---|
| Condominium | 29.44 | 11 | 4.98 |
| Shop House | 57.39 | 5 | 9.02 |

From Table-5 the average lot area data was used together with satellite images to calculate the number of households of each house type in five Sois along Lat Prao Road. The selected five Sois can be seen in the map shown in Fig. 5. The results of total household numbers in each Soi are shown in Table-6.


**Fig. 5** Sois selected for household calculation

**Table-6** Number of household in each Soi

| House Type | Number of Households (Households) | | | | |
|---|---|---|---|---|---|
| | Lat Phrao 63 | Lat Phrao 67/2 | Lat Phrao 69 | Lat Phrao 80/3 | Lat Phrao 91 |
| Single House | 456 | 91 | 118 | 263 | 147 |
| Condominium | 180 | 0 | 218 | 16 | 103 |
| Shop House | 33 | 0 | 19 | 26 | 0 |

## 5. Traffic volume survey at Soi's entrances

In order to verify the estimation model, another five dead-end Soi connected to Lat Prao Road that was not used in the creation of the model was selected. The reason that only dead-end Sois are selected is because the traffic measured at dead-end Soi's entrance will be the actual traffic generated from that particular Soi.

From 16th to 18th December 2009, the traffic survey was done with video cameras. Two hours of traffic was recorded at Soi's entrance and the traffic volume was counted later back in Japan. All transport modes including para-transit, bicycle, car, pedestrian was observe by watching the video records. The generated trips data of each transport modes collected at the entrances of five Sois connected to Lat Prao road are shown in table-7.

**Table-7** Result of the traffic survey

| | Walk (Trips) | Motorcycle (Trips) | Para-Transit (Trips) | Car (Trips) | Total (Trips) |
|---|---|---|---|---|---|
| Lat Phrao 63 | 317 | 163 | 115 | 263 | 858 |
| Lat Phrao 67/2 | 50 | 8 | 0 | 39 | 97 |
| Lat Phrao 69 | 66 | 23 | 36 | 190 | 315 |
| Lat Phrao 80/3 | 225 | 47 | 0 | 146 | 418 |
| Lat Phrao 91 | 73 | 95 | 100 | 80 | 348 |

## 6. Verification

In this study, the verification was done on all of conducted methods, from the generated trip base collected by household survey questionnaire, the generated trip base from the generated trip estimation model and traffic volume survey at Soi

entrances. The result of verification is shown in Fig. 6. Furthermore, the error margin of estimated value from the model and the actual measured value is shown in Fig. 7

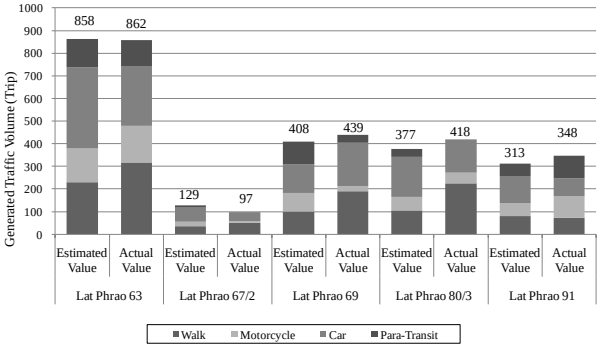


**Fig. 6** Comparison between estimated value and actual measured value

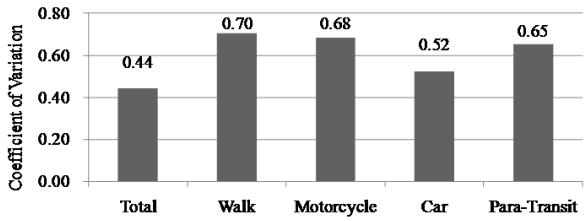


**Fig. 7** Error margin of estimated value from the model and the actual measured value

From the result shown in figure 6, all the traffic volume estimated by the estimation model show low error compared to the actual measured value. But the result from figure 7, when compared by different transport mode, the error is high. So it is assumed that the generated traffic estimation using this model with different transport mode cannot provide the preferable outcome.

Also from figure 7, with the error margin of total transport mode showing lowest result of 0.44 in coefficient of variation, it can be assumed that the estimation model produces a better result when the estimated with the entire transport modes together. Moreover, even though it didn't show in figure 6, all of walk traffic estimation results from the investigated Sois except "soi 91" were lower than the actual measured walk traffic volume, this is also unpreferable error. The reason for this is because the length of the actual measured Soi is shorter that the length of those Soi estimated by model, so residents tend to walk more in shorter Soi.

Therefore, people choose transport mode differently related to many factors such as the size of Soi, the shape of Soi and transport mode available in Soi. It is also considerable that the walking length to Soi entrance has a big effect to people's probability to walk. Therefore, to achieve more the from this study, the gathering of generated trip base data in more Soi and conducting questionnaire surveying in Soi with more variations in length and size will improve the outcome by reducing the errors now founded in the generated trip base estimation.

## 7. Result and issues of this study

In order to estimate the generated trip base, the household questionnaire survey was done based on three household types in Soi, the satellite images was used to count the number of households along with the average lot area calculation of households residing in shop house and condominium, the traffic volume generated from Soi is then estimated.

The compared results of the estimated value calculated by the estimation model and the actual measured value clarified that all transport modes generated traffic volume estimation is possible. The future issue is to decrease the errors founded in the separate transport modes generated traffic volume estimation.

To improve the accuracy of the estimation, it is important to cross investigate the shape and structure of particular Soi and how and in what modes people tend to transport in Soi.

In addition, since the study was done only in Sois connected to Lat Prao road, there are possibility that the peak rate $\beta$ value will be varied in different area. So it can not be concluded that the peak rate value used in this study is accurate. Finally, it is important to validate whether that the generated trip base estimation model's formula used in this study, can be use to estimates traffic in Bangkok's other area.