A STUDY ON THE ROLE OF BUS SERVICES TO MITIGATE MOTORIZATION IN HANOI

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Abstract: The ownership and mode share of motorcycle has growing up dramatically in Hanoi in last decade. The problems of heavy congestion, noise, air pollution and traffic accident have been caused by such rapid motorization and insufficient road network. Hanoi city government decided to introduce the model bus service in 2001 to solve such urgent problems. Besides, some policies have concentrated on restricting motorcycle ownership. The objectives of this study are to review the status of modal choice between motorcycle and bus by conducting two surveys, and to understand the attitude of citizen in Hanoi toward the actual urban transport conditions after the introduction of the transport-related policies. The survey on citizen's attitude toward the model bus service and urban transport problems including the person trip survey is conducted in 2002. From the survey result, we understand that Hanoi's citizens complain about the problem "directly" related to their daily lives, and any policy to improve the competitiveness of bus service such as frequent service, smooth operation and fare reduction is not effective to increase the share of bus service at the moment.

Key Words: Bus Service, Motorization, Mode Choice

1. INTRODUCTION

The public transport in Hanoi city had its golden age in the beginning of 1980s with highly mode share. However, after the introduction of "DoiMoi" policy (introduction of market economy oriented by Vietnam National Government in 1986), bus services quality had been fallen because of lack of the support from government. This fact resulted in the rapid decrease of bus users as shown in Figure 1. Until the year of 1992, the government started promoting the bus system, and as the result, the situation got improved. The number of bus user has been increasing little by little up to now. Such phenomena have little seen in our history.

At the same time, the mode share of private transport, especially motorcycle, has growing up dramatically. From the year of 1986 to 1999, the number of registered motorcycle had been growing up with the growth rate of about 14% per year. Chinese motorcycle with the lower price of 500USD compared with Japanese motorcycle (2,500 USD) introduced to the market, and this resulted in a "boom" of motorcycle ownership. The growth rate was 25% in the year of 2000, 29% in the year of 2001. This trend can be seen also in Figure 1.

The problems of heavy congestion, noise, air pollution and traffic accident have been caused by such rapid motorization and insufficient road network. Hanoi city government decided to introduce the model bus service in 2001 to solve such urgent problems. According to citizen's
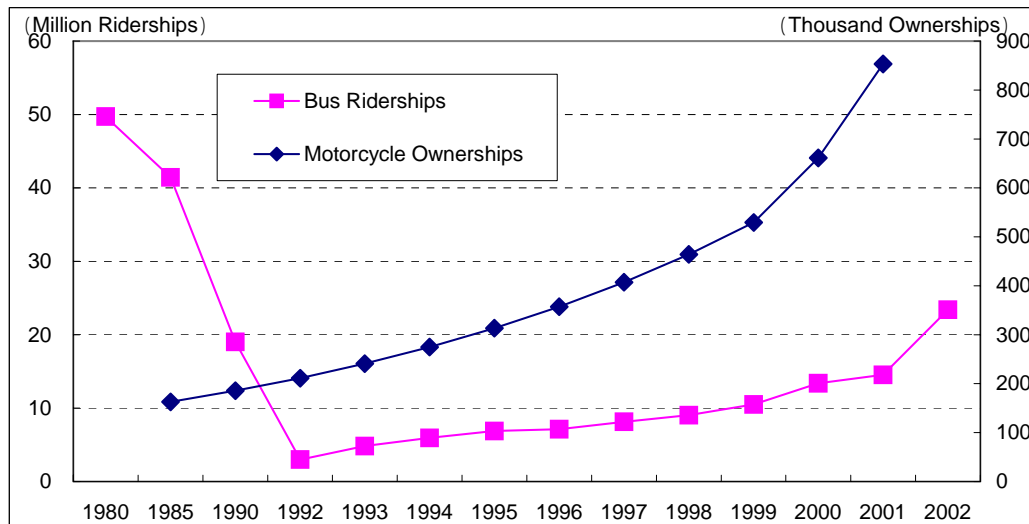
Figure 1. Trends of Motorcycle Ownership and Bus Ridership in Hanoi

custom of hating transfer on the way in Hanoi, the bus operation was designed with 5 routes for certain intervals. This weakened the dissatisfaction of transferring by bus users. At the same time, for smoother bus operation, some special control policies such as exclusive bus lane were introduced. In addition, any user is restricted to board onto bus freely along the streets, achieving the regularity of the bus service. These trials result in the recent increase of bus share.

Besides, some policies have concentrated on restricting motorcycle ownership. From January 6, 2003, new motorcycle registration is temporary denied as a social experiment. From January 1, 2003, 100% tax is charged to imported motorcycle. Imported motorcycle parts or machine are also taxed and carefully checked in quality. Even in the case of ownership transfer, highly fee is charged.

The objectives of this study are to review the status of modal choice between motorcycle and bus by conducting two surveys, and to understand the attitude of citizen in Hanoi toward the actual urban transport conditions after the introduction of the transport-related policies mentioned before. Chapter 2 describes the survey on citizen's attitude toward the model bus service and urban transport problems including the person trip survey conducted on November of 2002 in Hanoi city. The citizen's attitude toward the model bus service and urban transport problems are analyzed using categorical analysis in Chapter 3. The status of mode choice in Hanoi city is analyzed by person trip data collected in the survey in Chapter 4. The appropriate policy options for the promotion of public transport system are considered by estimating the mode choice model also in Chapter 4. Chapter 5 is conclusions.

2. QUESTIONNAIRE SURVEY IN HANOI

2.1 Survey Design

We conducted the questionnaire survey on citizen's attitude toward the model bus service and urban transport problems, and the person trip survey during October of 2002 in Hanoi city. The samples of totally 1,200 individuals were collected from whole Hanoi area.

In questionnaire of on citizen's attitude toward the model bus service and urban transport problems, respondents reply 4 subjects as follows. The individual attributes such as home and office address, job, income, motorcycle ownership, and so on are asked in Part A. The recognition and required improvement of Hanoi's transport condition are asked in Part B. The evaluations and mode choice status by motorcycle users are asked in Part C. The evaluations of model bus system are asked in Part D.

In person trip survey, respondents reply all trips generated on surveyed day with its origin and destination code (different from zone) that are set in advance, purpose, departure and arrival
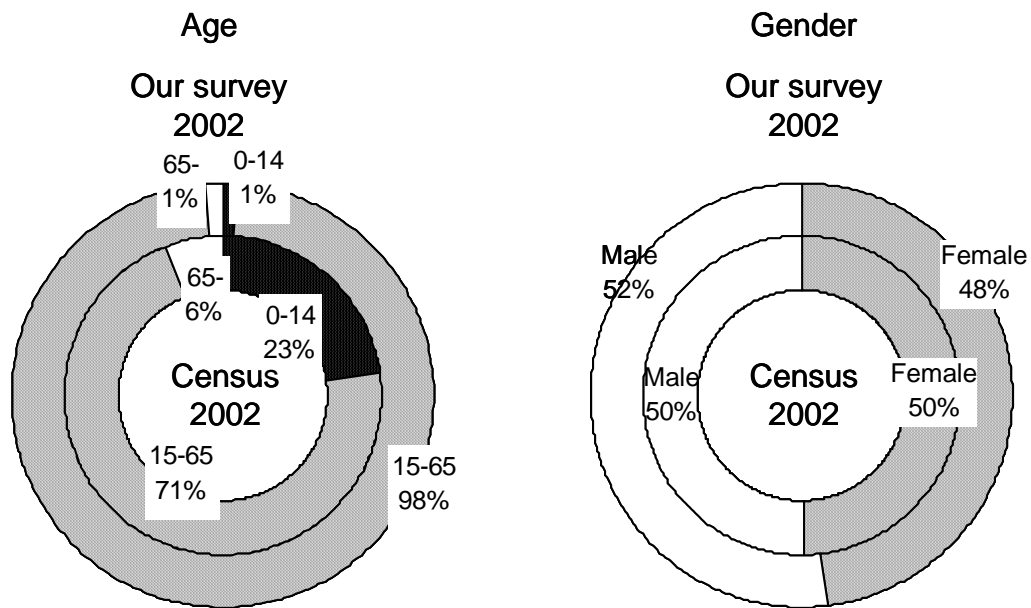
Age

Gender

Our survey
2002

Our survey
2002
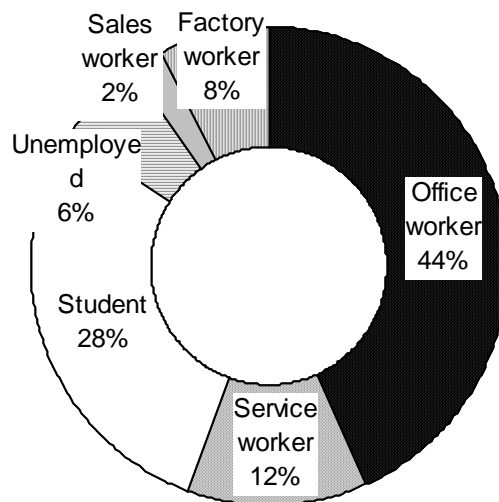

Figure 2. Proportion of Age and Gender

Figure 3. Proportion of Job Status

time, used mode, and so on.

2.2 Basic Data

The basic sample characteristics should be taken account into the considerations from analyses below. Figure 2 shows the proportion of age and gender from our survey and national census data in 2002. The gender proportion of our survey is almost same as that of census data, while we cannot obtain the samples in the category of younger and elder age.

Figure 3 shows the proportion of job status of survey samples. We cannot judge its generality because any data of job status authorized by national government cannot be obtained. Two-thirds of samples get income by themselves, and two-thirds of samples with job are office worker.

Figure 4 shows the proportion of chosen mode by trip from our data and government report in
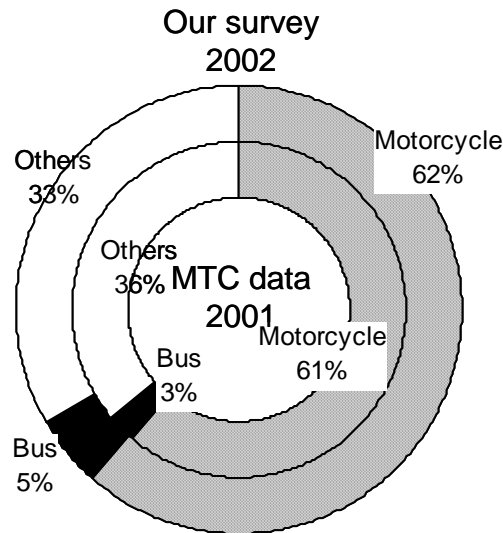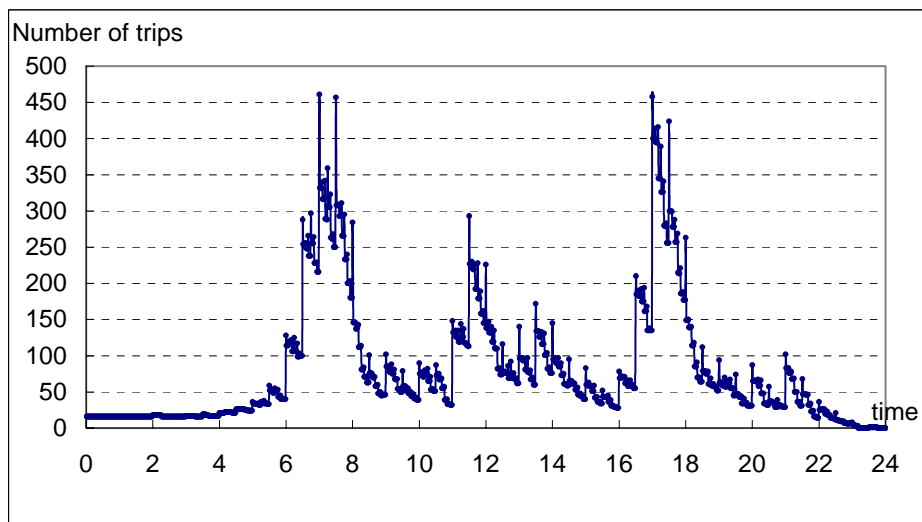
Figure 4. Proportion of Trip Mode

Figure 5. Trip Generation by Departure Time in our Person Trip Survey

2001. The bus share of our data is larger than that of government data. The reasons are considered two: the bus share has been increased for 1 year between national survey and our survey, or our sampling is biased. However, the share from two data sources is not so different.

Figure 5 shows the distribution of trip generation by whole about samples. Totally 4,000 trips with 4 peaks are obtained. In addition to usual 2 peaks at commuting hour (7:00am-7:30am) and returning hour (5:00pm-5:30pm), it is typical that there are 2 peaks at 11:30am to go out from office for lunch and 1:30pm to return to office. These phenomena may reflect the custom of Hanoi citizens in which office worker once go to home to have lunch with family and short noon recess. Besides, there may be many trips by students almost schools in Hanoi open mainly in the morning hours.

2.3 Zoning and Level-of-service Setting

The appropriate zoning is required for the person trip analysis. The zone size should be determined by the balance between sample size collected and area size. In this study, we introduce 27 zones as shown in Figure 6. According to the zonal sample size and population, zones in city center are relatively smaller, while zones in suburban area are larger.
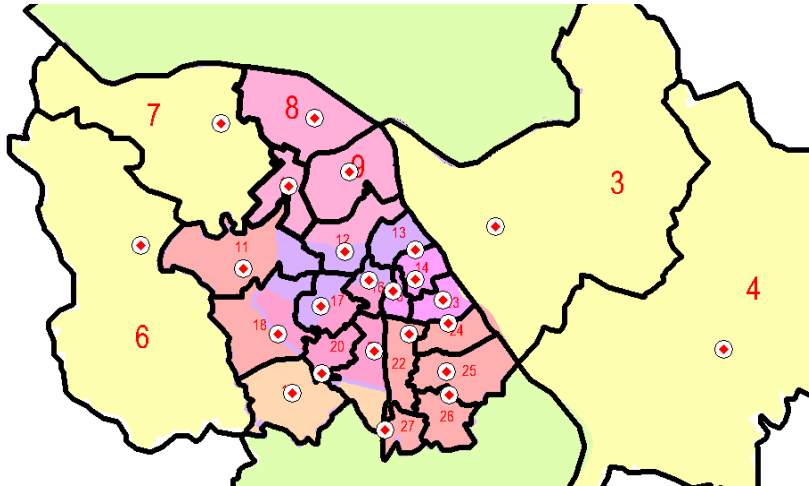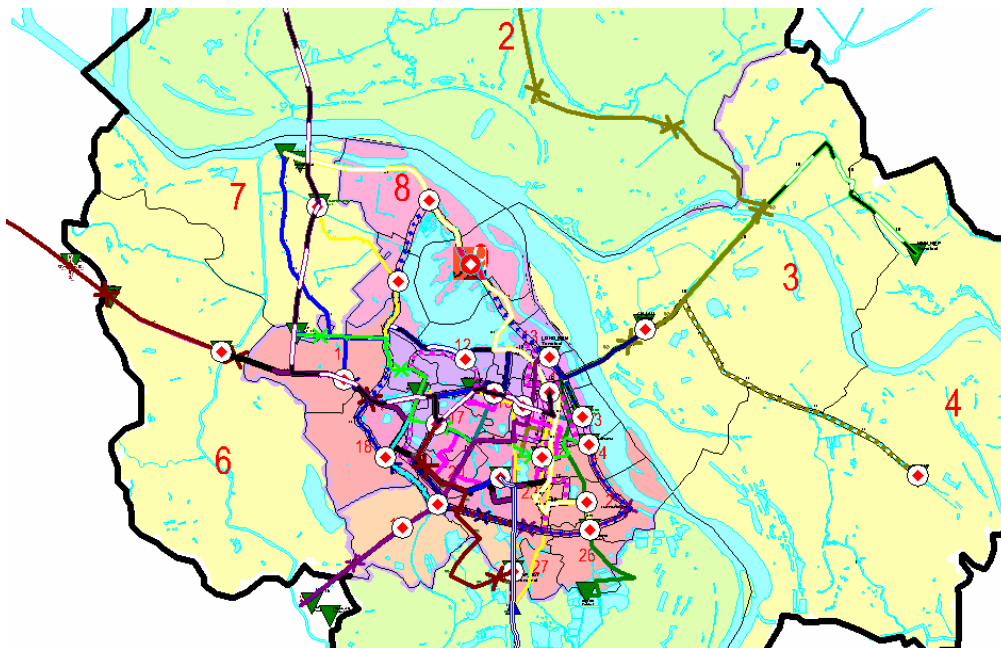
Figure 6. Zoning of the Person Trip Survey

Figure 7. Representative Center of Zone and Model Bus Network

We also set representative zone center considering the distribution and scale of several sub-center, and bus route in each zone. 28 bus routes are in service as of August 2002 by the data collected by other research. The level-of-service data such as fare, time, frequency, but stops and terminals, and so on are included in its database. Figure 7 shows the bus routes and representative zone centers. The level-of-service data for bus service between zones are calculated automatically by this database.

According to the bus service, we consider motorcycle for transport mode to be chosen in this study. We assume that motorcycle can run at the speed of 25km/h everywhere in Hanoi city. In this assumption, the travel time between zones by motorcycle is calculated by the distance between zones.

3. ATTITUDES TOWARD TRANSPORT PROBLEM BY HANOI'S CITIZEN

3.1 Evaluation of Urban and Transport Conditions

We asked the evaluation of 8 transport conditions, congestion level, accident level, noise level, air pollution level, citizen's manner in transport, roadside occupation, vehicle's quality and motorcycle boom. Each respondent is requested to reply the dissatisfaction level for transport
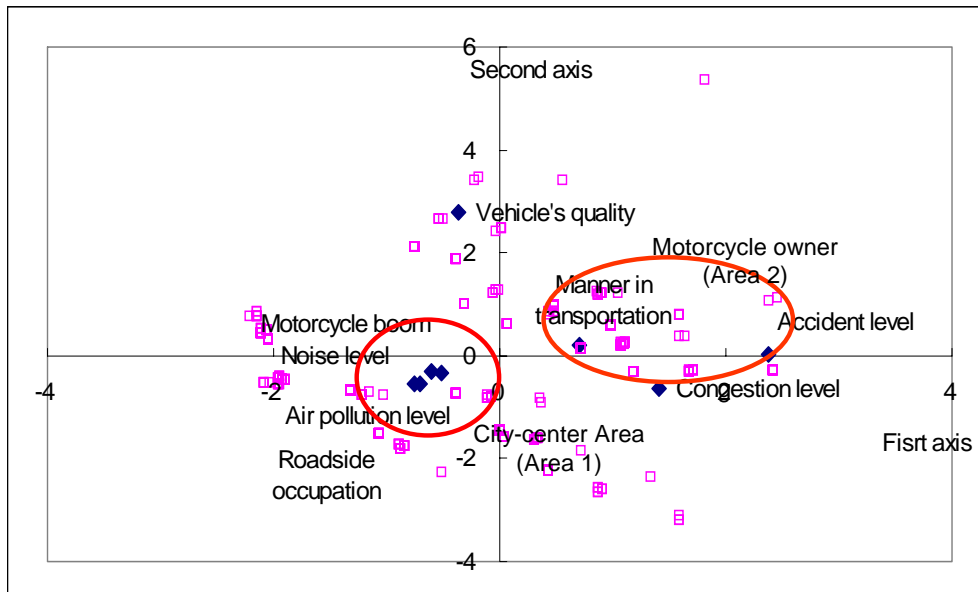
Figure 8. Result of Quantitative Analysis III (Urban and Transport Conditions)

condition by 5 categories, very good, good, fair, bad and very bad (5 categories are suppressed into 2 categories, good and bad in this study). The mapping analytical methodology of the Quantitative Analysis III is powerful toll to understand the relation among dissatisfactions and individuals in one graph.

Figure 8 shows the result of the Quantitative Analysis III applying to this dataset. We obtain 8 eigenvectors, and 2 eigenvectors with first and second largest eigenvalue are used to characterize the relation among dissatisfactions. The dissatisfactions of noise level, air pollution level, roadside occupation and motorcycle boom are plotted at the third quadrant (Area 1). This suggests that Hanoi's citizen relates the environment problems and motorcycle use. The dissatisfactions of congestion level, accident level and citizen's manner in transport are plotted around the positive side of the first axis (Area 2). This suggests that Hanoi's citizen considers the congestion and safety problem caused by the deterioration of manner in transport. And only dissatisfaction of vehicle's quality is plotted around the positive side of the second axis.

Sample variables of the first and second axis by every respondent are also plotted on the same graph. Many respondents living in the city-center area are plotted near Area 1. This suggests that the noise and air pollution level in city center area caused by motorcycle use is serious. Many respondents owning motorcycle are plotted near Area 2. This suggests that motorcycle user tends to complain about the traffic congestion and traffic accident. According to these results, Hanoi's citizens complain about the problem "directly" related to their daily lives.

3.2 Vital Factors of Mode Choice

To understand the characteristics of vital factors of mode choice is important for the introduction of appropriate transport policy, service and infrastructure. We asked the ranking of 6 important factors of mode choice, safety, fare level, convenience, travel time, travel distance and driver's service in Hanoi. Table 1 shows the result. It is interesting that safety and convenience are the more concerned factor than fare level and travel time. However, more dangerous mode of motorcycle is favorably used by Hanoi's citizen rather than bus which is safer. This fact suggests that citizens dare to use motorcycle because of its convenience complaining the danger of motorcycle. They may use motorcycle more frequently if safety condition is improved.

Table 1. Important Factors of Mode Choice by Hanoi's Citizens

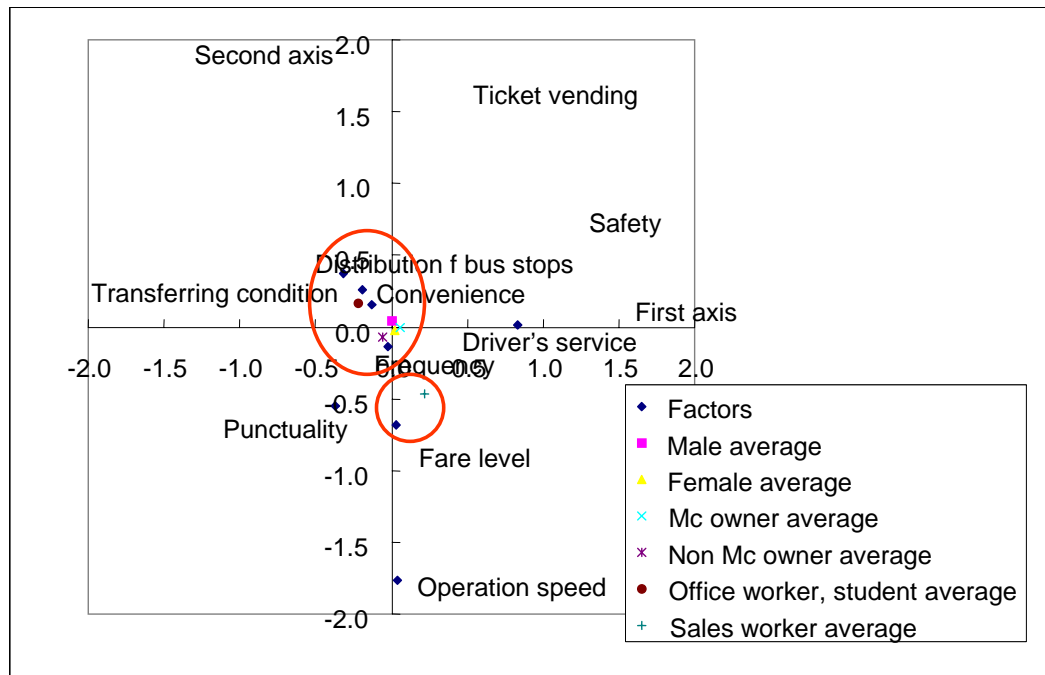| Factor	First	Second	Third
Safety	605	232	164
Fare level	58	253	296
Convenience	398	332	254
Travel time	79	219	238
Travel distance	24	100	147
Driver's service	35	63	100

Figure 9. Result of Quantitative Analysis III (Model Bus System)

3.3 Evaluation of Model Bus System

We asked the evaluation of 10 service factors of model bus system, driver's service, frequency, convenience, safety, punctuality, fare level, operation speed, distribution of bus stops, transferring condition and ticket vending. Each respondent is requested to reply the dissatisfaction level for service factor by 5 categories, very good, good, fair, bad and very bad (5 categories are suppressed into 2 categories, good and bad in this study). The Quantification Analysis III is also used for the analysis.

Figure 9 shows the result of the Quantitative Analysis III applying to this dataset. We obtain 10 eigenvectors, and 2 eigenvectors with first and second largest eigenvalue are used to the mapping analysis. The dissatisfactions of frequency, convenience, transferring condition and distribution of bus stops are plotted near (Area 1). The plots of other dissatisfactions are isolated each other.

The centers of individuals with same attribute are also plotted in Figure 9. There is little difference of positioning (in Area1) among attributes such as gender and motorcycle ownership. This suggests that many citizens complain about the total convenience of bus service. It is interesting that the center of sales occupation is plotted near to the dissatisfaction of fare level. This attribute may use bus service if the fare level in reasonable. According to these results, like in Section 3.1, Hanoi's citizens complain about the problem "directly" related to their daily lives.

Table 2. Estimation of Mode Choice Model

Explanatory variable	Parameter	t-stasistics
Travel time (inc. waiting time) (min)	-0.0530	-10.1
Travel cost (VND)	-0.000222	-2.74
Office worker and student dummy	-2.62	-6.04
Likelihood ratio	0.581	
Hit ratio (%)	90.2	
Samples	799	

4. CHARACTERISTICS OF MODE CHOICE IN HANOI CITY

4.1 Modeling of Mode Choice Behavior

The mathematical model that can analyze the effect of policy implementation in transportation on the behavioral change is required. Discrete choice modeling is one of the appropriate models to meet such necessity. We apply discrete binary logit model for the expression of mode choice behavior of Hanoi's citizen.

Choice probability of bus mode is expressed as follows,

$$P_i^b = \frac{\exp V_i^b}{\exp V_i^b + \exp V_i^c} \tag{1}$$

$$V_i^b = \sum_k \theta_k X_{ki}^b + \sum_k \delta_k \tag{2}$$

$$V_i^c = \sum_k \theta_k X_{ki}^c \tag{3}$$

where caption b expresses bus, caption c expresses motorcycle, i is individual, X_{ki}^m is the kth LOS variable of mode m for individual i, θ_k is parameter and δ_k is dummy parameter only for bus.

4.2 Estimation Result

As already shown in Figure 4, the modal share of bus is very low level. Many origin-destination pairs have no trip by bus. Trip makers should transfer more than twice or should pay higher bus fare in such case, and never use bus service. Such samples should not be included into the estimation dataset. To the contrary, the bus service and motorcycle are relatively competitive in a part of OD pairs because several bus trips can be observed. We selected 799 trips with such OD pair for the estimation dataset.

We try several combinations of explanatory variables such as travel time, cost and frequency. Finally, we obtain the estimation result in Table 2. Unfortunately, frequency is removed because travel time data includes the waiting time at bus stop and the correlation between frequency and travel time is so high. All parameters are significant judging from the t-statistics and marks. The likelihood ratio exceeds 0.5 and the hit ratio exceeds 90%, with higher goodness-of-fit indices. Job dummy parameter becomes negative value. This means that office workers and students with higher income tend to use motorcycle.

4.3 Sensitivity Analysis of Policy for Bus Services

The mode choice model we estimate includes travel time and travel cost. This is because we can grasp the effect of the policy changing travel time and fare on the choice probability.

Figure 10 shows the change of choice probability of bus service by the time and cost differences. When both cost and time differences are zero, the choice probability of bus service is about 6%. When the travel time of bus service is 30 min shorter than that of motorcycle and the travel cost of bus service is 5,000 VND cheaper that that of motorcycle, the choice probability of bus service exceeds 50%, this situation is unrealistic. According to our database, the average time difference between bus and motorcycle is 26 min, and the average cost difference is 833 VND, the choice probability of bus service is only 3 %.
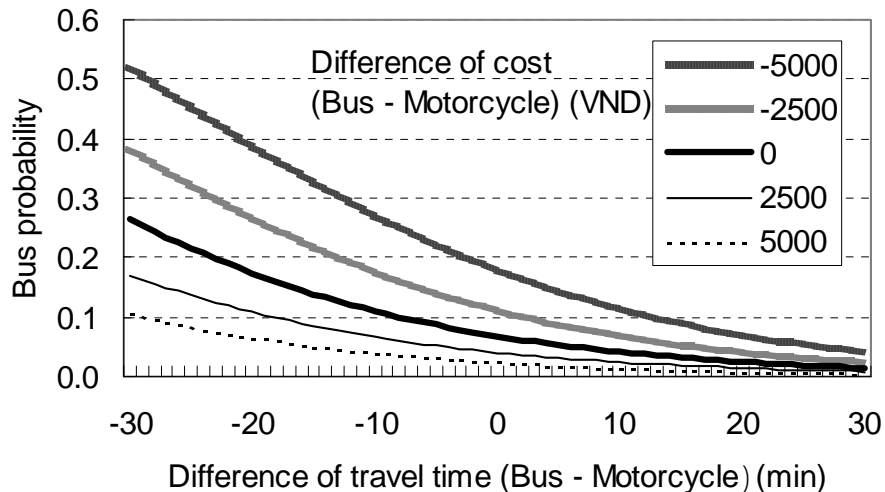
Figure 10. Relation between Bus Probability and LOS Differences

Although the model bus system is recognized, Hanoi's citizens are likely to choose motorcycle considering the model parameters. Any policy to improve the competitiveness of bus service such as frequent service, smooth operation and fare reduction is not effective to increase the share of bus service. However, if the usefulness of model bus is well recognized, Hanoi's citizens may change their travel behavior. This may result in the estimation of more sensitive models.

5. CONCLUSIONS

The ownership and mode share of motorcycle has growing up dramatically in Hanoi in last decade. This results in the problems of heavy congestion, noise, air pollution and traffic accident. To cope with such serious problems, Hanoi city government decided to introduce the model bus service in 2001 to solve such urgent problems. Besides, some policies also have concentrated on restricting motorcycle ownership.

This study aims to realize the possibility of public transport system like bus system in Hanoi by conducting original questionnaire survey. The survey is composed of two parts, one is citizen's attitude toward the model bus service and urban transport problems, and another is the person trip survey.

Firstly, the attitude toward transport problems is analyzed using mapping technique of the Quantitative Analysis III. We understand that Hanoi's citizen relates the environment problems and motorcycle use, citizens dare to use motorcycle because of its convenience complaining the danger of motorcycle, and many citizens complain about the total convenience of bus service. It is also indicated that citizen may use motorcycle more frequently if safety condition is improved in future.

Secondary, the sensitivity of policies for bus services is analyzed. We apply discrete binary logit model for the expression of mode choice behavior of Hanoi's citizen. By estimating the model, it is found out that office workers and students with higher income tend to use motorcycle. We analyze the change of choice probability of bus service by the time and cost differences using the technique of sensitivity analysis, and understand the pessimistic scenario of lower mode share of bus service although any policy is implemented at the moment. However, if the usefulness of model bus is well recognized, authors think that Hanoi's citizens may change their travel behavior.

For further study, we are now investigating the analysis of the status of motorcycle ownership in Hanoi. Such rapid motorization should be mitigated to lead the appropriate urban growth. In addition to the considerations from this study, we will finally propose the appropriate transport policy options to manage urban growth in Hanoi.

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