Motorcycles in Developing Asian Cities: A Case Study of Hanoi

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Abstract

The rapid rise in motorcycle transport in developing Asian countries and in particular in Vietnam, poses a challenge to planning authorities and policy makers. Very little is understood about responses of motorcycle users to policy instruments available to government to better manage the mode. This is an impediment to the planning and appraisal of policy initiatives, and hence efforts to reduce the adverse effects on present and future populations of the mode, including travel delays, health and safety impacts and emissions production. There is a need to better position the role of the motorcycle in providing urban mobility and its integration with other modes. This is especially the case considering potential changes to public transport options and the effect of rising incomes and car ownership. This paper describes a study undertaken on the use and ownership win the city of Hanoi, Vietnam. Focus groups, interviews, surveys and other data collection processes allowed for subsequent analysis and interpretations with the development of a policy model to test the effect of some potential policy initiatives. Results of the study and assembled data resources provide potential solutions for Vietnam and could be widely informative across East Asia and other regions where developing cities are facing similar challenges

1. Introduction

The rate of motor vehicle ownership in developing East Asian countries roughly tripled between 2003 and 2009 in line with nominal GDP per capita increases. Two wheeled motorized vehicles (hereafter ‘motos’) have accounted for much of this growth. The impact of increasing motorization and moto ownership has been particularly apparent in the cities of Vietnam.

Motos are a particularly interesting mode as they offer both problems and solutions to the challenge of providing urban transport. It is important to appreciate that motos provide levels of mobility that other modes have been unable to match in many developing cities. There are positive aspects of this mobility. For example, motos use much less roadway capacity relative to automobiles. This is particularly advantageous in cities where roads can sometimes occupy only 10 percent a city’s land area. However, the number of motos in Vietnam’s cities result in many challenges, including congestion, noise, emissions, and negative impacts on non-motorized transport and pedestrian spaces.

There is still very little that cities know about the drivers of demand for this mode. This paper describes some of the results of a research study undertaken in Hanoi, the capital of Vietnam. A particular focus is to identify the factors that drive modal shift to and from motos for different segments of the urban transport market. Lessons learned and potential solutions for Vietnam could be widely informative across East Asia and other regions where developing cities are facing similar challenges.

2. An Overview of Transport in Hanoi

Hanoi, the capital of Vietnam, is a city that had a population of 6.8 million people in 2012. Density is high, with 2,060 people per hectare (830 people per acre) in that year. Gross national income per capita for Vietnam in 2013, converted at the purchasing power parity exchange rate, was US$5,030, which compares with US$53,960 for the USA (World Bank, <http://wdi.worldbank.org/table/1.1> accessed July 24, 2014).

Between 2006 and 2011, the number of registered cars in Hanoi rose by 179 percent to 235,000 while the number of motorcycles rose by 85 percent to 4.0 million units. These average annual growth rates of 22.8 percent for cars and 13.1 percent for motorcycles are very high by international standards. The motorcycles registered in Hanoi in 2011 accounted for 10.5 percent of total number of motorcycles in the country. Based on population in that year, average ownership was 0.61 motorcycles per person, which is a little lower than in Ho Chi Minh City, the other major city in the country, where ownership was 0.70 motorcycles per person. It is judged that the latter may be close to saturation levels after allowing for those such as children and the aged who are unable to use motorcycles. Ownership of smaller pedal electric ‘xe dap dien’ that can be ridden by teenagers without a driving licence, and electric motos more generally, are an emerging trend.

Motorcycles in Hanoi, and Vietnam more generally, are now almost exclusively powered by four-stroke internal combustion engines, with fuel injection accounting for only a relatively small, albeit rising, share of the fleet. Engine size is low, with virtually all motorcycles and scooters in-use having engine displacement of less than 150 cc and with the most common size being 125 cc. European emission standards category 2, or ‘Euro 2’ standards (European Parliament and Council of The European Union, 2002), which define acceptable limits for exhaust emissions of new vehicles, were introduced two years after their application in Europe. There will be a ten year gap with regard to the full introduction of the generally more stringent Euro 3 standards in Vietnam in 2017. Even so, Euro 3 standard motorcycles have been available for some time. A research study of a sample of 1,000 in-use motorcycles in 2007 in Hanoi found that 52.9 percent of motorcycles had uncontrolled emissions, 38.1 percent met Euro 2 standards and 9.0 percent met Euro 3 standards (Nguyen and Mai, 2008). The growth in motorcycle sales since 2007 will have since reduced the share of motorcycles with uncontrolled emissions and increased the shares of the other two categories.

Other than for the purchase of new cars, taxes on vehicles and vehicle use are low. When purchasing a new motorcycle, there is an ownership registration tax and a one-off first-time registration fee that are in total around 10 percent of the cost of a motorcycle. A value added tax (VAT) of 10 percent also applies. For cars, there is in addition to VAT, an import duty of between 15 percent and 60 percent, a special consumption tax that ranges from 45 percent to 60 percent (depending on engine capacity) and an ownership registration tax and a one-off first time registration fee that are together a little over 20 percent. There were no ongoing annual registration or similar charge until 2013 when an annual road use fee was introduced at relatively low rates of US$7.50 per annum for motorcycles and US$78 for cars. The retail price for gasoline at the end of June 2014 was US$1.25/litre, indicating fuel taxes to be modest by international standards. The capital cost for a typical motorcycle, including taxes and delivery charges, is around US$2,200. Most motorcycles are purchased using family resources rather than finance from formal institutions. The cost of items that vary with use, e.g. fuel, tires, maintenance and oil, are low, at around 6.2 cents per motorcycle-km – this compares with around 31 cents per kilometre for these items for cars (all in mid-2014 prices).

Formal public transport in Hanoi is currently provided using a fleet of around 1,145 buses. There are 80 routes, with a route on most main roads. However, bus service frequencies are relatively low, with most routes operating at 10 or 15 minute headways. Only eight routes appear to have a peak period headway better than 10 minutes. The formal public transport system is complemented by standard taxis and a small informal motorcycle taxis. The limited scale of current formal public transport in Hanoi, illustrated by the small bus fleet relative to the population, is reflected in a mode share that seems to be only around 5 percent (though a rate of 10 percent is also reported based on high estimates of the number of trips made using monthly passes).

The combination of low public transport mode share and high motorcycle ownership makes Hanoi unique. In most major cities in developing countries private vehicle ownership is low and public transport plays a major role. In contrast, Hanoi is a city where the public transport mode share is similar to, if not lower than, that in most developed, car-dominated cities and it has a high rate of private vehicle ownership, albeit motorcycle rather than car.

Such an arrangement provides the community with a high level of mobility at moderate cost. It is not, however, without its challenges. The rapid growth in the number of registered vehicles has, in the face of only limited expansion of road capacity, led to traffic congestion that is generally widespread and which is severe in some locations. While wearing of helmets has become mandatory for motorcycle users, compliance rates are variable and helmet quality is generally poor. Accident rates are high, with motorcycle riders vulnerable to harm because of the lack of physical protection. The rapid growth in vehicles has led to a substantial increase in air pollution, with many motorcyclists wearing masks to reduce inhalation of pollution and dust. Motorcycle users, and car users too, are permitted in some circumstances to use footpaths for parking, and use them anyway in other cases. While motorcycles dominate the traffic flow as can be seen by the examples of traffic composition in Figure 1, the different operating characteristics of motorcycles, bicycles, cars, buses and trucks makes the flow uneven and reduces the effective road capacity as well as heightening the risk of accidents.

Figure 1: Examples of traffic composition in Hanoi.

|  |  |
| --- | --- |
|  | C:\Users\David\Documents\Consulting\Vietnam Moto (2013)\Photos\giao-thong2.jpg |

The Governments of Vietnam and Hanoi are aware of the challenges they face and have taken some actions to improve urban transport outcomes. The principal action has been to improve public transport, focused on the development of urban rail and complementary improvements to the bus systems. By 2030, it is intended that there will be a network of eight rail mass rapid public transport (MRT) lines and two bus rapid public transport (BRT) lines (GOV 2011a). Three of the MRT lines and one of the BRT lines are currently under construction, with detailed planning proceeding for the remaining MRT lines. The number of buses is forecast to rise to 1,730 by 2020 (UTC 2010). The target for public transport mode share is 35 percent in 2020 and 55 percent in 2030 relative to a reported mode share of 10 percent in 2010 (GOV 2011b).

3. The Research Study and Travel Behaviour Survey Methodology

The mode share targets for public transport in Hanoi are very ambitious. Achieving them in full, or even in significant part, will require a major shift of travellers from motorcycles to public transport and containment in the rise in car use. The World Bank commissioned a research study to gain a better understanding of the factors that influence mode choice of travellers in Hanoi. The research also examined matters related to improving traffic management and road safety. The purpose of the research was to provide evidence-based information that the government could use to refine its policies and practices as it seeks to secure the desired future for passenger transport in Hanoi. The research was undertaken by consultants in association with Vietnamese universities and with guidance and oversight from World Bank staff (Economic and Policy Services Pty Ltd et al, 2014).

The research included an initial stage to assemble a comprehensive understanding of passenger transport in Hanoi and to conduct focus groups. Six focus groups were conducted, each with around 10 representatives of a specific social group, to identify key issues additional to literature review findings on motorcycle ownership and use to be addressed in surveys with relevant attributes. Subsequently, major surveys of moto use, traveller views and traffic management were been undertaken. This paper reports on the results of the surveys of moto use and travel behaviour, including establishing a discrete choice modelling framework with the ability to represent mode choice by differing populations within the wider community of Hanoi.

The moto use survey involved observation surveys for three 2-hour periods (during the morning peak, a period after the morning peak and during the evening peak) at five locations in Hanoi. Locations were selected throughout Hanoi with varying degrees of traffic volume and servicing key routes in the city. A total of 91,000 vehicles were observed.

Based on the objectives of the study and the findings from the focus groups, two travel behaviour surveys were developed. Both surveys were implemented using students from the University of Transport and Communications in Hanoi, under the management of academic staff, to conduct face-to-face surveys with respondents using paper-based forms. This approach was judged to allow better management of sampling rates and survey quality and to be more appropriate to local conditions than use of internet or computer based approaches. Respondents for the interview surveys were approached at locations in all of Hanoi’s 21 districts, as interviewers invited them to participate on the spot. Monitoring of survey responses ensured that profiles for attributes such as age and gender were continually matched to census profiles. In both surveys, respondents were given a gift of a pen to acknowledge their participation. Respondents were also generally willing to provide contact details, which were used to follow up respondents on a sample basis to ensure that the surveys had been conducted appropriately. Pilot tests were used to ensure that the survey forms and arrangements used in the full deployment task were robust and efficient.

The objective of the first survey, described here as the mode choice survey, was to establish statistically valid explanations for quantitative factors that influence the discrete choice decision to use a motorcycle or some other mode of transport taking account of key variables that are open to policy influence (Table 1). They survey was primarily a stated preference (SP) survey design enhanced with inclusions for revealed preferences. Such a design allows for the development of the required database with representations for the motorized modes of motorcycle, car, taxi, bus and the proposed rapid public transport modes (i.e. MRT and BRT). The latter was made generic because neither exists at present and the community therefore has limited precise understanding of the service characteristics that MRT and BRT will provide. Chosen attributes and levels focus on the most significant parameters identified in literature and focus groups relevant to moto policy development and implementation strategies.

To provide a dataset with the greatest potential to given insight into travel choice and sound discrete choice model calibration without overburdening survey respondents, the survey design included:

* Each survey collected information on matters such as gender, household size, structure and income, housing type and vehicle ownership to allow the influence of socio-economic conditions to be determined. This same information was collected in both of the travel behaviour surveys.
* Respondents were presented with questions related to either a routine trip (such as journeys related to work or education) or a non-routine trip that they made. Equal numbers of surveys were conducted for each of these trip categories to give an adequate statistical sample and to reflect the broadly similar shares of each category of trip in total travel demand. Attributes of their current typical journey including door-to-door travel time were also recorded.
* Efficient design processes (Rose and Bliemer, 2009) with allowances for variable choice set sizes (Rose et al, 2013) and the NGene software (Choice Metrics 2012) determined that a minimum of 24 stated preference (SP) scenarios were required to address the choice variables. It was judged, following initial trialling of the survey, that respondents could typically accommodate a maximum of 9 scenarios. Accordingly, six survey forms were used for each of the two trip types, with the SP scenarios in each including 6 core scenarios and 3 of the remaining 18 scenarios. To avoid bias that could result from respondents tiring of the scenarios as they completed the survey, each of the 12 survey forms comprised two versions, one with the scenarios in one order and the other with the order reversed.

Once interpreted into the survey questionnaire, choice scenarios were presented with the general appearance as shown in Figure 2.

Table 1: Potential trip alternatives and attributes for the stated preference survey

|  |  |  |
| --- | --- | --- |
| **Travel Alternative** | **Attribute variables** | **Attribute Level Range** |
| ***Motorcycle*** | Cost of fuel | No change *to* 5,000VND (Vietnamese Dong)/km |
| Cost of parking | Free *to* 20,000VND |
| Door-to-door travel time | 50% decrease *to* 100% increase |
| ***Car*** | Cost of fuel | No change *to* 1,600VND/km |
| Cost of parking | Free *to* 80,000VND |
| Door-to-door travel time | 50% decrease *to* 100% increase |
| ***Motorcycle taxi*** | Fare | 10,000 *to* 60,000VND |
| Door-to-door travel time | 50% decrease *to* 100% increase |
| ***Bus*** | Fare | 5,000 *to* 30,000VND |
| Door-to-door travel time | 50% decrease *to* 100% increase |
| Walk associated with a bus trip | 2 minutes *to* 15 minutes |
| Arrival reliability | Within 5 minutes - within 15 minutes |
| ***Rapid Transit*** | Fare | 5,000 *to* 30,000VND |
| Door-to-door travel time | 50% decrease *to* 100% increase |
| Access associated with a metro trip | 2 minutes *to* 15 minutes |

Figure 2: Example stated preference choice task containing motorcycle and car

|  |  |  |
| --- | --- | --- |
|  | Motorcycle | Car |
|  | car_image.jpg |
| Fuel Cost | 800 VND /km  (Current Price) | 5,000 VND /km  (Double Current Price) |
| Parking Cost | 20,000 VND | Free |
| Door-to-Door Travel Time | No Change to Your Current | Half Your Current |
| Choice | 🞎 | 🞎 |

The survey was deployed between April and June 2014 (but excluded a week with a public holiday). The survey took an average of around 13 minutes to complete. Deployment occurred in all of Hanoi’s 22 districts, were distributed across the day and evening, and covered location types such as households, offices, schools, recreation areas, shopping malls, on-street, bus stops and parking areas. The intent of disaggregating the discrete choice model estimation by socio-demographic and trip-making characteristics required a substantial sample size. The low cost of survey deployment and data entry tasks allowed such a survey to be undertaken. For each of the routine and non-routine trip types, the objective was a minimum of 2,700 surveys to allow the complete survey database to be divided by up to five possible population sub-groups with sufficient statistical validity. In the end, a total of 6,047 survey responses were collected, with 5,993 complete records. This provided a database of almost 54,000 scenario choices. The sampling rates sought to match the gender and age profile of the population, and also to obtain a sufficient sample of lesser sub-groups such as bus and car users and higher income groups to allow a full model specification to be achieved.

The data allows mode choice model estimations to be made taking account of the mode attributes described in Table 1. Revealed preference data also allows for the identification of population sub-groups (based on socio-demographic and trip making characteristics), and hence the development of multiple discrete choice models that account for differences in choice-making behaviour between the groups. Utility functions and parameter estimates that are derived in the estimation process will provide the models with the ability to test a range of policy options on different population types. The current paper describes results of the analyses undertaken to date.

The second survey, described here as the travel quality survey, addressed the relative importance of service quality factors. The survey was based on quality of service factors that were identified in the focus groups and other discussions with full questionnaire presented in Economic and Policy Services Pty Ltd et al (2014). The front end of the survey used the same socio-economic questions as used in the SP survey so that relationships and connections between respondent cohorts from both surveys can be established. It also sought additional information on vehicle ownership and use. Finally, it used a Likert scale approach (Likert, 1932, Meyers et al, 2005) to identify the relative importance of 12 matters that can influence the choice to purchase a motorcycle and 17 matters that influenced or could influence the choice by respondents to travel by motorcycle, bicycle and bus. The survey was deployed in the same manner and at the same time as the mode choice survey. A total of 1,211 valid survey responses were collected.

4. Data Analysis

4.1 Travel Demand

The moto use survey illustrates the dominance of motorcycles in Hanoi, with the data indicating that:

* motos comprised 85.8 percent of the traffic flow, with cars, buses and trucks respectively accounting for 12.3 percent, 0.7 percent and 1.2 percent of the traffic flow;
* of the two-wheeled vehicles, 96.2 percent were motorcycles (on which occupants straddle the chassis), 0.6 percent were scooters (with a central footwell), 0.6 percent were electric scooters and 2.6 percent were bicycles;
* a relatively small 1.9 percent of motos carried a substantial quantity of goods;
* average moto occupancy was 1.22 persons, with 78.8 percent of motos carrying only the driver, 20.2 percent with one passenger, 0.9 percent with two passengers and a small number with 3 or 4 passengers – the average occupancy varied only marginally by time of day, and compares with a previous estimate of average car occupancy of 2.6 persons (JICA 2007);
* a little more than twice as many drivers were male (68.6 percent) compared with female (31.4 percent) – this is perhaps in some contrast with the female labour force participation rate in Vietnam in 2012 being 73 percent compared with a world average of 51 percent (http://wdi.worldbank.org/table/1.1, accessed 24 July 2014);
* 47.5 percent of moto occupants wore masks/comforters - people may wear masks where they have a cold or to protect themselves from cold air, though the conduct of the survey in late June, when weather conditions were fine, reduces the likelihood of these reasons, and hence the result is taken to indicate a concern about pollution;
* 4.4 percent of motos carried children (i.e. passengers judged to be under 15 years of age); and
* helmet wearing is generally high, with 98.0 percent of motorcycle drivers and a slightly lower 95.1 percent of adult passengers wearing helmets, but an alarmingly low 26.5 percent of children wearing them.

The mode choice survey provided information on the trips canvassed, including:

* The average distance of routine and non-routine trips was 6.8 km and 7.9 km respectively. Respective average travel times of 20.4 minutes and 20.9 minutes (giving average respective speeds of 20 kph and 23 kph) reflect the greater likelihood of non-routine trips occurring outside peak periods.
* Average travel speeds are relatively low, which is consistent with the level of traffic congestion, poor traffic behaviour and a general propensity to travel at low speeds.
* The majority of persons surveyed on routine trip activity reported that commuting was their primary trip purpose at (74 percent) with education following (at 20 percent). Other routine trip types combined accounted for 6 percent. Non-routine trip types were predominantly for shopping purposes (51 percent), closely followed by recreation (44 percent) and other purposes (5 percent).
* A feature of private mobility that is more difficult with public transport is the ability to stop in the course of a trip to undertake some additional activity. In the case of in Hanoi, 11.8 percent of the surveyed trips involved stopping off for at least one additional activity (with 1.9 percent of trips stopping 2 or 3 times). The main activities that respondents stopped to do were to pick up or drop of another person (44.2 percent of stops) and shopping (32.4 percent of trips).
* Free parking facilitates private travel, and 76.1 percent of respondents making trips by motorcycle did not need to pay for parking at their destination. The average cost of parking is, at $0.25 for motorcycles and $1.20 for cars, low.

The travel quality survey was used to obtain additional information about travel by the respondents as well as their views of the relative importance of matters affecting vehicle ownership and use. Of some note was their involvement in crashes:

* Of the sample of 1,211 respondents, 106 had been involved in a traffic accident in the previous 6 months, with property damage, minor injury and major injury accidents respectively accounting for 35 percent, 61 percent and 4 percent of the accidents. No fatalities occurred as a result of the accidents in this 6 month period.
* The frequency of accidents is high, with each person on average likely to be involved in an accident every 6 years. The vulnerability of motorcyclists to harm is indicated by the almost two-thirds who incur an injury.
* Respondents were also asked to indicate the number and types of accidents in which they had been involved in the prior 18 month period (i.e. from 6 to 24 months before the survey) and in the 3 years prior to that. The response was a much lower rate of reported accidents, with the accident rate for the 18 month and 3 years periods being 41 percent and 17 percent respectively of the initial 6 month period. While it is possible that accident rates has increased over time, the lower rate for more distant periods is considered to more likely reflect diminished memory, and is a caution for surveys that seek information on events that occurred some time ago. Public accident statistics are of insufficient quality to allow benchmarking of the change in accident rates over time.

In addition, the survey was used to assemble information on motorcycle ownership. The data indicated that motorcycle ownership by people from households with income in the lowest quintile was half of that for people from households with income from the highest income quintile (0.46 motorcycles per person versus 0.95 motorcycles per person). Ownership was very closely correlated with income (see Figure 3), suggesting that ongoing increases in personal income could result in continued growth in the ownership and use of vehicles.

Figure 3: Motorcycle Ownership and Income in Hanoi



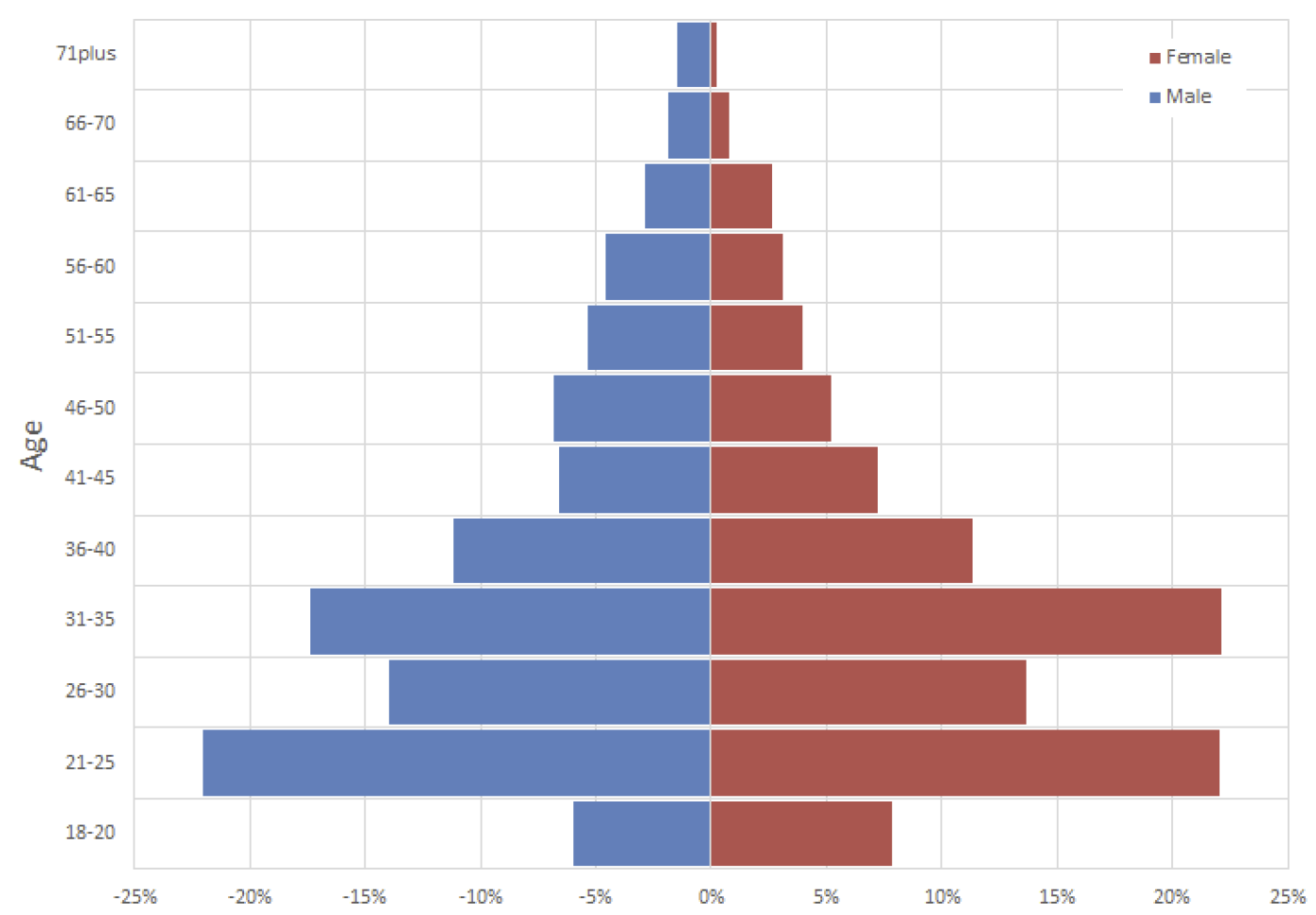
4.2 Travel Choice

The results of the mode choice survey have been utilised to estimate discrete choice models representing the mode choice decisions of Hanoi residents. Inclusions such as revealed preference responses allow for multiple models estimations with respect to various trip purposes based on routine and non-routine trip types. Prior to this estimation process, important stages associated with data checking and filtering, reformatting and general sample profiling prepare for the estimation of choice model structures and parameters and to ensure confidence in model estimation result.

The full sample of survey respondents aged over 18 years achieved a male-female split of close to 50-50 with a total male sample of 2,972 and total female sample of 3,021 (see Figure 4). The majority (62 percent) of all respondents are aged 35 years or younger and reported household incomes reveal that the majority of respondents (38 percent) are from middle-income house-holds earning from between 10-20 million VND (equal to $600-$1,200 at the exchange rate in 2014) per month.

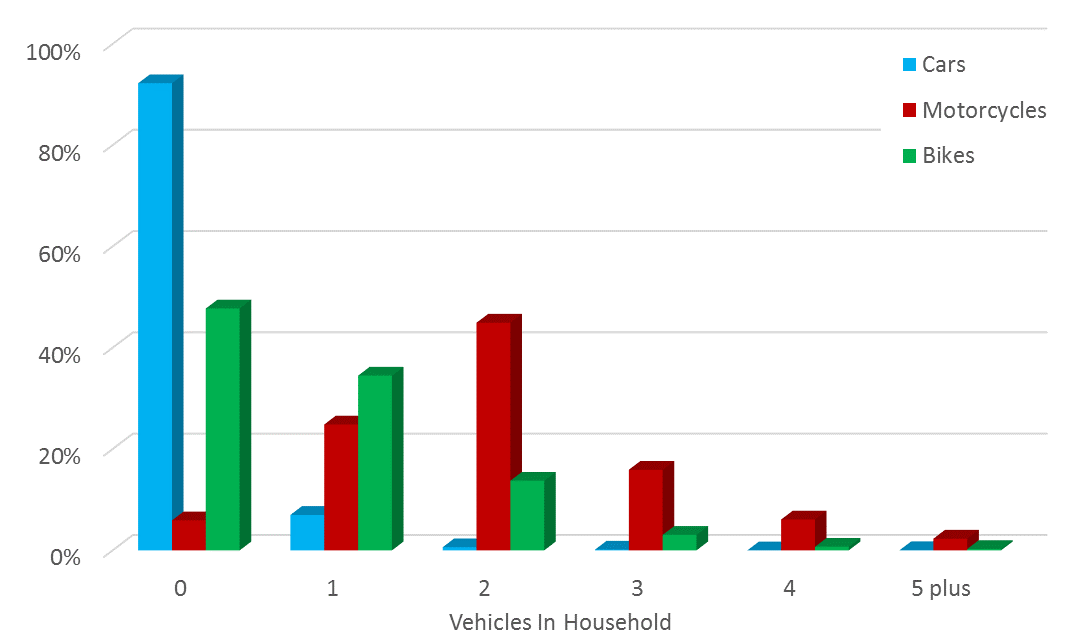
The vast majority (92 percent) of households do not own a car. As expected, motorcycle ownership is quite a different situation with very few households with no motorcycles (Figure 5) and the majority of households owning at least 2 motorcycles totalling 11,993 individual motorcycles identified. From this initial sample profiling it is observed that the ‘average’ survey respondent will have a limited experience with car ownership but likely to have good knowledge of motorcycle ownership in the household.

Figure 4: Sample population for mode choice survey - age and gender profile



On a weekly basis a larger number of routine than non-routine trips are performed. Work and education based trips are similar number with 6.1 to 6.6 trips per week on average. Other routine trip types are slightly lower at an average of 5.3 trips per week and have more deviation in the reported response. The average routine work trip travels a distance of 7.2 km taking 21 minutes. Across all trip purposes, the average travel speed is low at 21 km/hr.

Figure 5: Sample population household vehicle ownership profile



Discrete choice modelling is widely used in transportation modelling to represent the choice of one from a set of mutually exclusive alternatives. The multinomial logit model (Hensher et al, 2005, Louviere et al, 2000) provides a useful mechanism for employing discrete choice modelling, requiring estimation of utility function coefficient parameters. Estimation processes are assisted with the application of the NLOGIT software (Greene, 2007), allowing for the application of the commonly used maximum likelihood estimation process (Louviere et al, 2000). Individual estimations were conducted for routine work, education and other trips as well as the combined non-routine trips.

For the routine work trip purpose estimation, a log-likelihood result of -15,966 was achieved after five iterations. Table 2 provides a summary of the parameter estimates for this trip purpose, along with non-routine trips. The table also reports on parameter estimate significance, a two tailed test of the hypothesis that the coefficient equals zero.

Estimation results reveal that all parameters present a negative sign, indicating that any increases in the time or cost attributes for any of the modes will reduce the attractiveness of that mode to the traveller. Alternative specific parameters for all modes have a high significance indicating that there is a reasonable contribution of unobserved effects for all modes. Travel time is especially relevant to the work trip as starting work time is an important component of the travel to work choices and all modes demonstrate the importance of travel time in the representation for choice. Other attributes that play an important role in the utility function include the public transport fare, fuel and parking cost for the car but less so for the motorcycle mode.

Estimations for the routine and non-routine trip purposes was achieved with a low number of iterations for the maximum likelihood estimation convergence. In these results, all modes demonstrate the importance of travel time in the representation for choice, it being most significant for the motorcycle, bus and motorcycle taxi modes whilst less significant for the rapid transit and car mode alternatives. Other attributes that play an important role in the utility function generally include the public transport fare, fuel and parking cost for the car but less so for the motorcycle mode. In all cases, the ASC has high significance indicating the importance of unobserved effects or effects that have not been specifically defined in the survey.

The estimation of elasticities for all trip purposes and modes (Table 3) reveals that respondants are willing to pay for motorcycle use under a significant cost increases. This is emphasised by parking cost and indeed travel time inelasticity, especially for the work trip. Only substantial increases to fuel or parking pricing or travel time will result in substantial shifts in travel demand.

Table 2: Utility function parameter estimates for routine work and non-routine trips

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Mode** | **Parameter** | **Routine Work** | | **Non-Routine All** | |
| **Estimate** | ***Sig.*** | **Estimate** | ***Sig.*** |
| Motorcycle | ASC | 1.4952 | *0.0000* | 1.8582 | *0.0000* |
| Fuel Cost | -0.0001 | *0.7194* | -0.0004 | *0.0004* |
| Parking Cost | -0.0053 | *0.3347* | -0.0116 | *0.0114* |
| Travel Time | -0.0115 | *0.0000* | -0.0076 | *0.0000* |
| Car | ASC | 1.6141 | *0.0000* | 0.8380 | *0.0000* |
| Fuel Cost | -0.0002 | *0.0000* | -0.0001 | *0.0767* |
| Parking Cost | -0.0086 | *0.0000* | -0.0048 | *0.0012* |
| Travel Time | -0.0068 | *0.0000* | -0.0007 | *0.4887* |
| Motorcycle Taxi | ASC | 0.0000 | *-* | 0.0000 | *-* |
| Motorcycle Taxi Fare | -0.0066 | *0.0004* | -0.0099 | *0.0000* |
| Travel Time | -0.0047 | *0.0008* | -0.0019 | *0.0462* |
| Bus | ASC | 0.6513 | *0.0000* | 0.6896 | *0.0000* |
| Public Transport Fare | -0.0145 | *0.0000* | -0.0149 | *0.0000* |
| Walk Time | -0.0101 | *0.0750* | -0.0131 | *0.0119* |
| Travel Time | -0.0066 | *0.0000* | -0.0027 | *0.0002* |
| Rapid Transit | ASC | 1.0640 | *0.0000* | 0.8817 | *0.0000* |
| Public Transport Fare | -0.0145 | *0.0000* | -0.0149 | *0.0000* |
| Walk Time | -0.0101 | *0.0750* | -0.0131 | *0.0119* |
| Travel Time | -0.0071 | *0.0000* | -0.0001 | *0.8937* |

*Note: ‘ASC’ = Alternative Specific Constant, ‘Sig.’ = significance.*

Table 3 Elasticity estimates by trip purpose

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Mode** | **Parameter** | **Routine Work** | **Routine Education** | **Routine Other** | **Non- Routine** |
| Motorcycle | Fuel Cost | -0.0044 | -0.0158 | -0.0301 | -0.0388 |
| Parking Cost | -0.0045 | -0.0092 | -0.0446 | -0.0097 |
| Travel Time | -0.0223 | -0.0157 | -0.0451 | -0.0168 |
| Car | Fuel Cost | -0.1342 | -0.0831 | -0.1559 | -0.0487 |
| Parking Cost | -0.0350 | -0.0408 | -0.0202 | -0.0210 |
| Travel Time | -0.0300 | -0.0187 | -0.0823 | -0.0028 |
| Motorcycle Taxi | MC Taxi Fare | -0.0695 | -0.1915 | -0.2652 | -0.1055 |
| Travel Time | -0.0350 | -0.0201 | -0.0426 | -0.0145 |
| Bus | Public Transport Fare | -0.0737 | -0.1511 | -0.1599 | -0.0695 |
| Walk Time | -0.0171 | -0.0726 | -0.1441 | -0.0247 |
| Travel Time | -0.0562 | -0.0404 | -0.0362 | -0.0212 |
| Rapid Transit | Public Transport Fare | -0.0491 | -0.1196 | -0.1118 | -0.0560 |
| Walk Time | -0.0171 | -0.0726 | -0.1441 | -0.0247 |
| Travel Time | -0.0273 | -0.0359 | -0.0177 | -0.0006 |

Rapid transit travel time is relatively inelastic, especially for non-routine trips where any increase in travel time will have little effect on ridership. Motorcycle taxi fare has a high elasticity indicating that decreases to this have the potential to attract passengers from other modes. The results of additional analysis processes summarized by Economic and Policy Services Pty Ltd et al (2014) reveals that travellers with longer journey distances by moto are more likely to change their travel choices if fuel prices rise and women are, on average, more responsive to changes in public transport travel time.

4.3 Influence of Qualitative Factors on Vehicle Ownership and Travel Choice

Key results of the travel quality survey with regard to vehicle ownership and travel choice are shown in Tables 4 and 5 respectively. Consistent with the high accident rate, respondents consistently ranked safety features as matters that strongly influenced their decisions with regard to vehicle ownership and also for vehicle use. Notably, bus users also ranked personal security as their most serious concern with regard to trip making. Bus use also attracts a range of other concerns, in particular travel time, flexibility, personal space and reliability.

Also of particular note is that people purchasing electric scooters and bicycles rate the capital cost of these vehicles as a matter affecting vehicle purchase choices: given a limited number of electric scooters, this is likely to reflect the low income of the people involved. In a similar manner, people who are likely to purchase motorcycles are more concerned about vehicle and fuel cost than car purchasers. The high level of concern for fuel cost by electric scooter and bicycle users indicates the importance of this factor in favour of a vehicle that does not use gasoline.

Table 4: Importance of quality factors for vehicle ownership

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Factor** | **1=not important, 5=important** | | | | | |
| **Primarily a car user (N=54)** | | **Primarily a motorcycle user (N=947)** | | **Primarily an electric scooter or bicycle user (N=128)** | |
| **Mean** | ***Coeffi­cient of Variation*** | **Mean** | ***Coeffi­cient of Variation*** | **Mean** | ***Coeffi­cient of Variation*** |
| Cost of vehicle purchase | 2.7 | *0.51* | 3.6 | *0.34* | 4.1 | *0.23* |
| Registration fee | 1.9 | *0.47* | 2.5 | *0.44* | 2.9 | *0.35* |
| Road maintenance fee | 2.1 | *0.47* | 2.4 | *0.44* | 2.8 | *0.40* |
| Insurance cost | 2.3 | *0.48* | 2.6 | *0.42* | 3.0 | *0.35* |
| Fuel cost | 3.3 | *0.38* | 3.9 | *0.28* | 4.3 | *0.19* |
| Maintenance cost | 2.2 | *0.44* | 2.7 | *0.44* | 2.9 | *0.36* |
| Parking fee | 2.1 | *0.66* | 1.8 | *0.56* | 2.2 | *0.50* |
| Other costs | 2.1 | *0.50* | 2.5 | *0.45* | 2.9 | *0.38* |
| Finding a place to park | 2.4 | *0.60* | 2.0 | *0.56* | 2.4 | *0.48* |
| Having a driving licence | 3.2 | *0.40* | 3.3 | *0.38* | 3.6 | *0.28* |
| Safe travel on the road | 4.6 | *0.11* | 4.7 | *0.12* | 4.8 | *0.09* |
| Vehicle safety features | 4.2 | *0.22* | 4.4 | *0.17* | 4.4 | *0.18* |
| Average | 2.8 | *0.44* | 3.0 | *0.38* | 3.4 | *0.32* |

Table 5: Importance of Quality Factors for the Last Motorized Trip Made (by Mode Used and Alternative Modes)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Factor** | **1=not important, 5=important** | | | | | |
| **Travel by Motorcycle**  **(N=1,216)** | | **Travel by Bicycle**  **(N=1,216)** | | **Travel by Bus**  **(N=1,216)** | |
| **Mean** | **Coeffi­cient of Variation** | **Mean** | **Coeffi­cient of Variation** | **Mean** | **Coeffi­cient of Variation** |
| Travel time | 3.07 | 0.44 | 3.00 | 0.44 | 3.53 | 0.34 |
| Cost | 3.10 | 0.38 | 1.81 | 0.61 | 2.50 | 0.47 |
| Road safety | 4.23 | 0.25 | 3.61 | 0.36 | 3.32 | 0.43 |
| Personal security | 3.41 | 0.40 | 3.05 | 0.47 | 3.97 | 0.27 |
| Environment benefit | 3.22 | 0.34 | 2.30 | 0.55 | 2.90 | 0.40 |
| Flexibility | 2.75 | 0.52 | 2.67 | 0.44 | 3.39 | 0.32 |
| Ease of carrying goods | 2.43 | 0.52 | 2.38 | 0.47 | 2.78 | 0.44 |
| Personal space | 2.37 | 0.52 | 2.34 | 0.50 | 3.42 | 0.32 |
| Reliability | 2.82 | 0.48 | 3.02 | 0.38 | 3.42 | 0.33 |
| Ease of accessing location | 2.57 | 0.57 | 2.37 | 0.57 | 2.93 | 0.45 |
| Weather conditions | 3.58 | 0.30 | 3.57 | 0.30 | 2.64 | 0.46 |
| Heavy traffic conditions | 3.90 | 0.27 | 3.25 | 0.40 | 3.35 | 0.41 |
| Stress experienced while driving | 2.89 | 0.45 | 2.26 | 0.53 |  |  |
| Presence of dust and exhaust fumes | 3.69 | 0.31 | 3.54 | 0.34 | 2.34 | 0.48 |
| Air conditioning | - | - | - | - | 3.42 | 0.38 |
| Number of transfers | - | - | - | - | 3.43 | 0.36 |
| Convenience of getting to bus stop | - | - | - | - | 3.75 | 0.31 |
| Average | 2.00 | 0.41 | 2.80 | 0.45 | 3.19 | 0.38 |

*Note: Coefficient of variation = standard deviation divided by the mean. It is an indication of the relative extent of dispersion of views.*

5. Discussion

The surveys provide considerable insights into the ownership and use of motos in Hanoi. Several key themes that are important with regard to the future management of motorcycles emerge.

The first is that motos have attributes that make them attractive to users and provide the key mobility requirements for most people. The attributes cited in the surveys include flexibility with regard to travel location, travel time and household travel arrangements, as well as moderate purchase costs and low operating costs. But there are also factors that make moto use unattractive, including poor safety, air pollution and hot and wet weather, which are especially unpleasant for longer distance journeys.

By comparison with general international experience, travel demand elasticities calculated using the survey information are very low. This indicates that people have well-established, if not deeply entrenched, travel behaviour. With regard to the key government objective of seeking a shift to public transport, moto users showed only a very limited willingness to switch to other modes in the near future. They felt that public transport, bus in particular, did not match the positive attributes of motos and was not sufficiently attractive to overcome the unappealing features of moto use.

However, the surveys also show that people have differing views and that some market segments are more willing to transfer to public transport than others. Government will achieve the greatest and most cost-efficient transfer to public transport by focussing on the market segments that are most amenable to change. As examples, the surveys indicate that:

* Women, on average, are likely to be more easily persuaded to use public transport than men though they are concerned about their safety and security. Not all women will be able to change as some need the greater flexibility of motos to undertake more complex travel to meet family needs.
* Moto users who travel long distances are more likely to be attracted to public transport than those who travel shorter distances.
* People with higher incomes are more likely to own and use cars; however, they also value their travel time and hence can be attracted to fast, high quality public transport when they need to travel to locations where congestion is serious.
* People are bothered more by some parts of a public transport trip than others. For example, the surveys indicate people are much more concerned by the time and bother of the walk to access public transport that the time spent on the public transport vehicle, and they are less bothered by the time spent travelling on rapid transit than on bus. International experience indicates that the need to transfer between public transport services is disliked by passengers.
* Other matters related to public transport that people are concerned about include safety and personal security, over-crowding, service reliability and air conditioning.
* People generally do not rate fares as being a major issue, though people with lower incomes are more concerned and people with higher incomes and people who would use rapid transit are less bothered by the level of fares.
* Moto users are concerned by travel conditions, including travel time, weather conditions, traffic conditions, and the presence of dust and fumes.
* In other respect, views generally do not differ substantially by age, gender and the presence of children in a household. The principal variations are that people from households with higher income are less concerned with the cost of using their vehicles and those from households with low income are more concerned with travel time and road safety.

The focus of the research was on moto ownership and use, and the potential for a shift from motos to public transport. Information was also collected on attitudes to car ownership and use because of the rapid growth in the role of the mode and the potential for rising income to allow moto owners to purchase and use cars. The size of the sample of current car users was sufficient to ensure statistical significance, though it was small relative to the sample of moto users and will have been influenced by current features of car users (e.g. being those with higher incomes and with many having chauffeurs). In addition, where non-car users were asked about their attitudes to car ownership and use, there is a risk that it may have been difficult for them to have envisaged such a situation and to give reliable indications.

In the absence of a marked change in government policy and personal choices, the current average rate of moto ownership in Hanoi of 610 motos/1,000 people could rise to around 700 motos/1,000 people (or 2.75 motos per household on average), which is the current level of moto ownership in Ho Chi Minh City. This would be approaching the saturation level where everyone who is able to use a moto has access to one. It is possible that moto ownership will remain high even as car ownership increases, as has been the case in Taipei in Taiwan (Chen et al, 2013 and Tuan et al, 2013). If the experience in Taipei was to occur in Hanoi, car ownership could rise from 36 cars/1,000 people at present to one car per household. This would see a seven-fold increase on the number of cars on the road in Hanoi. The augmentation from moto to car ownership has already commenced, with the number of registered cars in Hanoi during the period 2006 to 2011 rising at almost double the rate of motorcycles.

6. Conclusions

Government in Vietnam faces many challenges that result from the rapid motorization of transport in its cities. The sheer number of motorcycles is the clearest evidence of this. The faster still increase in the number of cars poses an even greater challenge - while motorcycle ownership may be near saturation, current low level of car ownership and the potential for continued growth as rising incomes make cars more affordable presents an even greater challenge because of the greater road space required by cars and the effect of more of the larger vehicles on the dynamics of traffic flow.

In Hanoi, the government is aiming to substantially improve public transport, primarily through construction of an extensive metro rail system supplemented by BRT and better street buses. The success of these improvements is dependent on attracting substantial numbers of people who currently use motorcycles to public transport. There is a complementary need to maintain the attractiveness of motorcycle travel relative to car to slow the rate at which people shift to car.

Although there are multiple objectives of the wider study upon which this paper is based, presented here are selected highlights of the research process and outcomes. The components described in this paper provide a better understanding of the factors that influence the purchase of motorcycles and use of the various modes of transport that will be available to the community in Hanoi. It indicates the major challenges facing urban authorities as they seek their desire for a shift from private to public modes of transport.

Acknowledgements

The support of the Government of Australia in financing the research study is acknowledged, as are comments and other inputs from other staff and consultants of the World Bank and other consultants participating in the research. The views expressed in this paper are those of the authors and do not necessarily represent those of the Government of Australia, World Bank or the Government of Vietnam.

References

Ben-Akiva, M., and Lerman, S.R. (1985). Discrete Choice Analysis: Theory and Application to Travel Demand, MIT Press Series in Transportation Studies.

Chen, B.W., Takami, K, Ohmori, N. and Harata, N (2013). Household Car and Motorcycle Ownership and Transaction Behavior through a Life-Course Approach - a Case in Taipei City. Papers of the *10th Conference of the Eastern Asia Society for Transportation Studies*, September 9-12, 2013, Taipei, Taiwan.

Choice Metrics (2012). Ngene Version 1.1.1: User Manual and Reference Guide, Choice Metrics Pty. Ltd.

Economic and Policy Services Pty Ltd with the support of the University of Transport and Communications, Hanoi and Associated Consultants (2014). Motorization and Urban Transport in East Asia: Motorcycle, Motor Scooter and Motorbike Ownership & Use in Hanoi (4 volumes). December.

European Parliament and Council of The European Union (2002). Directive 2002/51/Ec on the reduction of the level of pollutant emissions from two- and three-wheel motor vehicles and amending Directive 97/24/EC, Official Journal of the European Communities.

Greene, W.H. (2007). LIMDEP V9.0 Econometric Modelling Guide, Econometric Software Inc

Government of Vietnam (2011a). Hanoi Urban Transport Master Plan.

Government of Vietnam (2011b). Hanoi Urban Master Plan.

Hensher, D.A., Greene W.H. and Rose, J.M. (2005). Applied Choice Analysis: A Primer, Cambridge University Press.

Japan International Cooperation Agency and Hanoi People’s Committee (2007) The Comprehensive Urban Development Programme in Hanoi Capital City of the Socialist Republic of Vietnam (HAIDEP). March

Likert, R. (1932). A Technique for the Measurement of Attitudes, Archives of Psychology, Vol. 140, pp. 1–55.

Louviere, J.J., Hensher, D.A., and Swait, J.D. (2000). Stated Choice Methods, Analysis and Application Cambridge. Cambridge University Press.

Meyers, L.S., Guarino, A. and Gamst, G. (2005). Applied Multivariate Research: Design and Interpretation. Sage Publications.

Nguyen, T. K. O. and Mai. T. T. P. (2008). Emission Inventory for Motorcycles in Hanoi Using the International Vehicle Emission Model. Prepared for Regional Workshop for East Asia on the Partnership for Clean Fuels and Vehicles. Bangkok: Environmental Engineering and Management Program, School of Environment, Resources and Development, Asian Institute of Technology.

Rose, J.M. and Bliemer, M.C.J. (2009). Constructing Efficient Stated Choice Experimental Designs, Transport Reviews: A Transnational Transdisciplinary Journal, 29:5, 587-617.

Rose, J.M., Louviere, J.J. and Bliemer, M.C.J. (2013). Efficient stated choice designs allowing for variable choice set sizes, International Choice Modelling Conference, Sydney, Australia.

University of Transport & Communications (2010). Bus Development Plan 2020. April.

Vu Anh Tuan, Iderlina B. Mateo-Babiano (2013). Motorcycle Taxi Service in Vietnam – Its Socioeconomic Impacts and Policy Considerations. Papers of the *10th Conference of the Eastern Asia Society for Transportation Studies*, September 9-12, 2013, Taipei, Taiwan.