Quantify Benefits of Cycling Space Development in Jakarta

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Abstract: This study aims to quantify the benefit of cycling space development in Jakarta. There are very few studies which evaluate benefits of cycling, especially if cyclist’s conditions including road facilities are improved. Improvements on health, accidents, air pollution, travel time, saving on parking costs, vehicle cost and security enjoyments were considered as benefits in this study. As quantifying was done without established data and value available, the Contingent Valuation Methods (CVM) including Willingness to Pay (WTP) and Willingness to Use with considerations and realistic assumptions were introduced as methodology. The results show that development of cycling space is valuable measures, especially on saving of user cost. This is because the higher interest to cycling among the large number of motorized vehicles in Jakarta. This study is designed to discuss the framework of methodology, therefore the finding could be developed to be more comprehensive quantifying for the further research.

Key Words: Jakarta, Cycling, Benefits.

1. INTRODUCTION

The crucial transportation problem in Jakarta is how to provide mobility services for all segment of community. One of the approaches to problems is to develop Non Motorized Transports (NMT) as a main mode in connected with public transport for the lower income peoples. NMT in here may include walking, cycling and some types of paratransits. Walking is fundamental human activities to provide basic mobility and serve many other functions. And cycling provides connections among various modes, destinations and activities. Therefore, improving these modes will also improve access by other modes. For short distances, NMT is the most efficient mean of mobility, while for longer distances public transport or cars offer greater efficiency.

Unfortunately, during the period of rapid motorization until several years ago, there have been no studies and policies which acknowledged the existence of NMT as a part of the transportation system in Jakarta. Because of the lack of information concerning potential usage of NMT, there were a few transportation studies which have recommended facilitating the use of these modes (Rahmah, 2007). The data of vehicle population shown in Figure 1.
could indicate this phenomena, where motorized vehicle increased approximately 2.5 times every 10 years. On the same time, the study of ‘Integrated transport master plan in Jabodetabek (SITRAMP) phase I shows that share of NMT decreased from 60% (1970s) to 28.8% (2000). NMT in this figure includes walking, cycling and types of paratransits.


Figure 1 Motor vehicle Population in Jakarta 1990 - 2015

However, in the last five years, there has been the strong political support from Jakarta’s city government for development of NMT. A pedestrian mall project has been under construction since 2007 on Kota Tua area, Central Jakarta. The project also included the restoration of areas along the Jl. Kali Besar. In case of cycling, there is a discourse from Jakarta’s Government to develop first Jakarta’s cycling space and its discourse was already included in the Rancangan Tata Ruang Wilayah DKI Jakarta 2030 (Jakarta Master Plan).

2. PURPOSE AND METHODOLOGY

NMT provides many benefits for transportation, environment and community on the overall. But, the conventional planning tends to undervalue these modes. Cost benefit Analysis is used to evaluate the impacts of road improvement projects in Jakarta and many other cities in Indonesia. However, analysis was not yet used to assess the impacts on NMT facilities improvements. The reason for this might be that the evaluation of impacts are very difficult to make an adequate valuation, therefore the results of estimation will be uncertain. From this perspective, NMT may have a minor role to play in overall transport system. In here, recognizing and quantifying the benefit of NMT improvements are needed.

The objective of study is to discuss the framework of methodology in order to quantify benefits of cycling space development if they are improved in Jakarta. There are two methods are often used for valuing benefits without established value and data available: Hedonic pricing and Contingent valuation Methods (CVM), including Willingness to Pay (WTP). Hedonic pricing uses regression analysis, often utilizing real estate values and other characteristics obtained from records of sales, and CVM uses some type of survey to value how people are willing to pay for benefits of proposed project. However, some studies mention that Hedonic Pricing might be difficult to undertake in a developing country because of the lacking of valid and network data. Therefore the methods of WTP and Willingness to Use will be suitable as the base of estimation. And, to quantify uncertain factors, several consideration and realistic assumptions will be tried to introduce as methodologies.
The quantifying will be carried out in five stages as shown in Figure 2. At first, we will determine the representative location for survey. In the second stage, we will estimate the demand for the proposed facilities and the change of behavior obtained by the improvement. In the third stage, we evaluate how facilities will impact the mobility and the fourth stage will determine benefit of facilities. And as the final stage, the benefit for facility improvements will be valued.

Therefore, there are two scenarios for study. First is to estimate the change of cycling demand with and without improvement by using questionnaire survey and data of Jakarta traffic volume. Second is to quantify the impact and benefit of improvement, based on results of questionnaire survey and literature reviews.

The fixed location and characteristics of Jakarta’s cycling space still was not yet announced. However, the proposed location will be centered in South Jakarta, from Jl. Lebak Bulus to Jl. Pondok Metro and Jl. Sisingamangaraja. The other planning is concerned the section in Blok M-Sudirman and Kuningan area. Considering to aspect of traffic volume, Sudirman Street was chosen as a representative location for questionnaire survey, as shown in Figure 3. Based on SITRAMP study in 2004, corridor of Sudirman-Thamrin had the highest travel demand in Jakarta, also as one of area for Jakarta’s Car Free Days every Saturday.
3. LITERATURE REVIEW

Reviewing past researches on the subject of Cost Benefit Analysis (CBA) on cycling space improvements was the first step of our approaches. This study tries to explore the literature study of CBA’s cycling study for Bogotá in Colombia, Delhi in India and Morogoro in Tanzania as shown in Figure 4. The selected cities are located on three different continents and they have different characteristics. These literature reviews show the different benefits were used in each study. Based on this reviewing, this study will be able to compare these literatures with existing condition of Jakarta.

![Figure 4 Comparison of benefits of cycling space improvement in three studies](Source: Non-motorized transport in developing countries, Final Reports Interface for Cycling Expertise.)

In Bogota, the Bicycle Master plan consists of the construction of a 300 kilometers long route network, with bicycle paths of 150 km and network of other high-quality bicycle amenities. The master plan will result in an increase of bicycle use from 0.58% of total number of trips to 3-5% in 2009. With an autonomous increase in mobility of 2.5% per year, it will lead to 953,000 bicycle journeys per day in 2009. And 843,000 trips are extra bicycle trips. The construction will show an increase of bicycle use from 0.58% of total number of trips to 3-5% in 2009. Number of bus and car trips will reduce by 472,000 and 168,000 respectively. The total benefits are 1,302 million USD and outcome of C/B is 1:7.3 (Servaas, 2000).

The study in Morogoro primarily focuses on the savings of user cost. The investments in road facilities consist of the construction of cycle paths and safe pedestrian’s crossings (40,000 USD per km) and bicycle lanes with traffic calming measures (20,000 USD per km). The total costs are 1.3 million USD, i.e 190,000 USD per year (10% interest rate, a 10 year period). The difference in travel costs are 11 million USD in 10 years, assuming that bicycle use will increase from the actual 20 to 30% in 2010. All other potential benefits, such as savings on investments for motorized transport, environment, quality of life, traffic safety are not considered. The outcome shows the positive C/B ratio of 1:5.30.

In the case of Delhi, the improvements include construction of a cycle path and bus lane. The reconstruction will cost about Rs. 26 million (520,000 USD in 2011 rate) per kilometer. Maintenance will be about Rs 2.6 million (52,000 USD in 2011 rate) per kilometer. Depreciation period is 25 years for infrastructure, the discount rate amount to 6% per year. The benefits will be considered from an improved traffic flow, accommodating 400 instead of 290 buses per hour in each direction, and 100% more cars per hour. For estimating the
environmental and user costs, the study compares the situation which 7% of trips are made by bicycle with the situation that no cycling exists any longer in Delhi, due to safety and environmental reasons. Savings fuel cost and costs of air pollution are Rs. 68.1 million (1.36 million USD in 2011 rate) and Rs. 14.5 million (290,000 USD in 2011 rate) per year respectively. The outcome of C/B ratio is 1:20.

4. RESULTS AND DISCUSSION

The numbers of respondents collected for the questionnaire survey were 104, consisted of 57 respondents of car drivers and 47 respondents of motor bike drivers. The reason why public transport is excluding on survey is to consider the actual condition that traffic vehicles volume in Sudirman is dominated by passenger cars and motor cycle (69% and 24%). The survey was conducted by direct interview methods for respondents whom passed and regularly used the location of survey for daily trips. The respondents were chosen randomly. 64 percents of respondents were male, as shown in Figure 5. The figures demonstrated that higher portion of car driver females came from people with younger aged. This is parallel with condition on the field where office and business facilities are mainly located.

![Figure 5 Overview of respondents based on gender and category of ages](image)

It is needed a test to ensure that the questionnaire is valid and reliable. The questionnaire assessment was done by using two kinds of test, namely validity and reliability test. The whole question in questionnaire is built according to its structures and questionnaire has been convergent with the research problem. In this research, the internal consistency was expressed by alpha Cronbach as shown in Equation 1.

$$\alpha = \frac{K}{K-1} (1 - \frac{\sum_{i=1}^{K} \sigma_{x}^{2}}{\sigma_{s}^{2}})$$  \hspace{1cm} (1)

Where, K = number of components (K-items or testlets), $\sigma_{x}^{2}$ = variance of the observed total test scores, $\sigma_{i}^{2}$ = variance of component i for the current sample of persons.

Alpha can take on any value less than or equal to 1. Higher value of alpha is more desirable. Therefore, the questionnaire with a higher alpha Cronbach value more than 0.60 is considered the survey with a higher reliability. The value of alpha Cronbach for respondents in this survey is 0.674 for car driver and 0.726 for motor bike driver. According to the reliability and consistency test, it can be concluded that the questionnaire is valid and reliable.
4.1 Estimating new demand of development

The future demand will be estimated from question: “If facilities are improved, will you change your current vehicles to cycling? The result shows that about three in fifth respondents will change their modes to cycling as shown in Figure 6. The future demand is estimated on the basis of the current condition and assumption about percentages change for motor vehicle volume based on the survey results. The assumed effects on reduction of motor vehicles for these findings are reflected in Figure 7, with the following assumption can be concluded.

1) The calculation for motor vehicle volume on Sudirman is 215,000 unit vehicles per day (JICA 2001). Data on traffic volume and vehicles composition are compiled from traffic counts conducted by the Local Transportation Agency (DISHUB, 2001)
2) However, the categories of motor vehicles were classified into several categories such as car, bus, minibus, truck, motor bike, etc. In here, the share of vehicles in Sudirman Street was 69% for passenger car and 24 % for motor bike.

Figure 6 Willingness to cycling for cycling space development

Figure 7 Assumptions on reduction of motor vehicle usage

4.2 Determining benefit of development

It may be very difficult to estimate the benefits of cycling space development as the range of impacts are large. Litman (2009) identified that the impact of improvements can be classified as qualitative or quantitative. Qualitative impacts are concerned with enjoyment, security, safety, etc. Quantitative impacts include health, air pollution and so on. To consider the cycling space development in Jakarta, some kinds of benefits as shown in Table 1 were treated in this study.
Table 1 Kinds of benefits on cycling space developments

<table>
<thead>
<tr>
<th>Impact of improvements</th>
<th>Resulted benefits</th>
<th>Contents of benefits</th>
<th>Point of indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>Health improvements (ΔBh)</td>
<td>Activities for cycling everyday would have a major effect on the prevention of premature death and diseases</td>
<td>Increasing of physical activities and premature death risk</td>
</tr>
<tr>
<td>Road safety</td>
<td>Reduction of traffic accidents (ΔBa)</td>
<td>Activities for cycling with safer facilities will reduce the number of traffic accidents involving pedestrians, cyclist and drivers.</td>
<td>Reduction of fatalities and injuries</td>
</tr>
<tr>
<td>Vehicle Cost</td>
<td>Vehicles cost Saving (ΔBcsc)</td>
<td>Cycling is not only a cheap mode of transport for society, the mode individual</td>
<td>Fuel, Maintenance and Part Cost saving</td>
</tr>
<tr>
<td></td>
<td>Parking cost saving (ΔBpcc)</td>
<td>Reduced motor vehicles trips may result in user’s parking cost</td>
<td>Reduction of parking fee</td>
</tr>
<tr>
<td>Travel Time</td>
<td>Travel Time (ΔBtt)</td>
<td>Reduced motor vehicles trips may result in fewer time spent for travel</td>
<td>Reduction of travel time</td>
</tr>
<tr>
<td>Security and Enjoyment</td>
<td>Increasing security and user’s enjoyments (ΔBscsc)</td>
<td>Cycling is one of the most popular form of physical recreational activities. More safer and secure cycling condition can provide user’s enjoyment.</td>
<td>Physical recreational and user’s enjoyment</td>
</tr>
<tr>
<td>Environments</td>
<td>Reduction of air pollution (ΔBe)</td>
<td>Cycling can help to reduce urban air pollution.</td>
<td>Reduction of death and diseases risk</td>
</tr>
</tbody>
</table>

4.3 Quantifying the benefits of development

4.3.1 Benefit on Health (ΔBh)

There is the overwhelming evidence that physical inactivity increases the risk of several diseases. Based on the study of Rutter (2005), it is possible to reduce mortality risk by increasing the level of physical activities as shown in Figure 8. There is a relationship between minutes of cycling per day and relative risk of death. This figure shows that the relative risk is halved by two hours cycling per day. Daily 30 minutes commute by bicycle might reduce the disease risk with 25%.

(Source: Rutter, Publication by Nordic Council of Ministers, Copenhagen, 2005)

Figure 8 Relation between regular cycling activities and relative risk of death

Table 2 Standards of risk reduction based on physical activities

<table>
<thead>
<tr>
<th>Disease</th>
<th>Denmark</th>
<th>WHO</th>
<th>Swiss</th>
<th>Practicable Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>32</td>
<td>33</td>
<td>46</td>
<td>40</td>
</tr>
<tr>
<td>Cardiovascular disorders</td>
<td>&gt;20</td>
<td>47</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>50</td>
<td>20-25</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Breast cancer</td>
<td>20</td>
<td>20-25</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Colon cancer</td>
<td>50</td>
<td>20-25</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Gallstone</td>
<td>34</td>
<td>34</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>68</td>
<td>68</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Back pain</td>
<td>26</td>
<td>26</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Note: Disease risk reduction by moderate exercise in %
Literature reviews above show that people who take their bicycle to work have a 28% lower mortality rate in comparison with the average. Table 2 also summarizes the findings of Europe and WHO standards that depressions, back-pains, hypertension, cancer, diabetes, etc can be reduced 20 to 68 % by regular cycling activities (Ege and Krag, 2006). Based on these findings, this study agreed to the standard 30-50 reduction on relative risk of death.

Health benefits will be valued through the framework of methodology as shown in Figure 9. The next question is Value of Statistical Life (VSL) for Jakarta. VSL is an economic value assigned to life in general and commonly determined by looking at a person's WTP. In this study, the VSL is identified by the value of WTP for 30-50% of death risk reduction based on respondent’s replies.

In order not to overestimate, the following assumptions can be concluded:
1) The health benefits only accrued to new cyclists, not to existing cyclists.
2) We assumed that only cyclist aged over than 30 and will regularly cycling to work/school would be affected.

Figure 9 Methodological frameworks for quantifying benefit on health

Figure 10 WTP for health in related with level of income for new cyclists

Figure 10 shows the distribution of respondents who are willing to pay for 30-50 percents mortality risk reduction in related with their income level. The average of WTP for a
respondent with income more than 10 million rupiah (3.1%) is 225,000-425,000 Rupiah. Respondents with income level 2-5 million Rupiah (47.6%) are willing to pay 68,000 – 172,000 Rupiah. This category can be determined as normal average for Jakarta’s resident income. Total average of the WTP for health from respondents who shift from motorized vehicles to cycling is 80,222 – 176,075 Rupiah or equivalent with 8.9 – 19.5 USD. However, when we estimated the WTP for respondents aged more than 30 and work only, the value is lower than the average as shown in Table 3.

<table>
<thead>
<tr>
<th>Calculation</th>
<th>WTP per year (in 1.000Rp)</th>
<th>Reduction of vehicles per year</th>
<th>Benefit on health ( in million US$ )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shifting from car to cycling:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car drivers with aged more than 30</td>
<td>633 (Max.value)</td>
<td>46,831</td>
<td>3.2</td>
</tr>
<tr>
<td>and willing to cycling for work</td>
<td>958 (Min.Value)</td>
<td></td>
<td>4.9</td>
</tr>
<tr>
<td>Shifting from motorbike to cycling:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor bike drivers with aged more</td>
<td>338 (Max.value)</td>
<td>12,076</td>
<td>0.4</td>
</tr>
<tr>
<td>than 30 and willing to cycling for work</td>
<td>564 (Min.value)</td>
<td></td>
<td>0.7</td>
</tr>
</tbody>
</table>

The US$-IDR conversion in 2010, US$1 = IDR Rp 9,000

4.3.2 Benefit on Road Safety – Reduction of accidents (ΔBa)

It is evident that decreasing motor vehicles will reduce traffic injury and fatalities, but there have been little direct researches concerned with these relationships. On the other hand, majority of researchers agreed that a cycle space with safer facilities is likely to reduce the number of traffic accidents involving cyclists (Saelensminde, 2005). But there is no evidence for the risk of accidents related to cycling facilities.

Therefore, it is particularly hard to value the benefits on reduction of accidents, but we know that the impacts are not less. In this case, it is possible to consider the following literature findings:

1) Generalized Linear Regression Model (GLM) is proposed to value the relationship between facilities and bicycle injuries developed by Jacobsen (2005). Jacobsen compared cycling and walking volumes and injuries based on five datasets from 68 Californian cities, 47 Danish towns and 14 European countries, and proposed to describe the empirical rule between injuries and bicycle/pedestrians as shown in Equation 2:

\[ I = aE^b \]  \hspace{1cm} (2)

Where, \( I \) is the injury measure, \( E \) is the measure of cycling, \( a \) and \( b \) is the parameter. The injury risk per capita can be measured by dividing both sides of Equation 2 by \( E \), resulting in the Equation 3.

\[ \text{Injury Risk} = \frac{I}{E} = aE^{(b-1)} \]  \hspace{1cm} (3)

In other words, this model predicts that cyclist’s injury risk would decrease to 66% of the current injury risk if cycling in a community is doubled.

2) Robinson (2005) reviewed three data sets in Australia, and was able to verify that the study also produced results similar to GLM model. He found that a doubling of the cycling distance per capita was associated with a 35% decrease in the risk of fatality per kilometer cycling.
Moreover, he found that a doubling of the volume of regular cyclists was associated with a 34% decrease in bicyclist injuries. The literature suggests conclusions that although increased bicycle injuries is associated with increased cycling, total injuries involving car, motor bike, and bicycle will decrease as more travel is done by cycling, less by motor vehicles, and the number of bicycle injuries increases more slowly than the number of bicycles.

Road safety benefits will be valued through the methodological framework as shown in Figure 11. The value of reduction of accidents quantified through two assumptions as follows. 1) There is no reduction on fatality accidents. The reason is that we have assumed that the number of fatality is not affected by shifting from motor vehicles to cycling. 2) For valuing the relationship between facilities and injuries, we assumed a 0.4 reduction on accident rate caused by shifting to cycling with GLM Model as base of estimation as shown in Table 4. And, cost of injuries is valued through the standard for Technical Assistance of Road Project Indonesia (Laporan Akhir Biaya Kecelakaan Indonesia, 1991).

Figure 11 Methodological frameworks for quantifying benefit of on road safety

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Reduction of accidents rates (%)</th>
<th>Reduction of number of accidents</th>
<th>Cost of accidents (in 1,000 Rp)</th>
<th>Benefits (in million US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents involving vehicles</td>
<td>NA*</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Reduction on fatal accidents</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Reduction on injuries for cycling</td>
<td>0.39</td>
<td>5,616</td>
<td>662**</td>
<td>0.15</td>
</tr>
<tr>
<td>Shifting from car to cycling</td>
<td>0.4</td>
<td>662</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>Shifting from motorbike to cycling</td>
<td>0.4</td>
<td>662</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

*NA: No data and proven evidence available
**Cost of injuries through Gross Output method by Technical Assistance of Road Project, Indonesia

4.3.3 Benefit on air pollution reduction (ΔBec)

In Jakarta, motor vehicles are regarded as the main sources of air pollution while cycling produce no emissions. Emission from motor vehicles causes significant damage to human health. People who are exposed to high levels of emissions may suffer from respiratory disease, lung damage, or even cancer. The types of emissions are Carbon monoxide (CO), Nitrogen oxides (NOx), Sulfur oxides (SOX), (VOC) and Fine particulates (PM10). Asri and Hidayat (2005) identified the recent monitoring data in Jakarta shows excessive PM10 concentration is the major cause of the air pollution and the recent study estimated that more than 70% of PM10 emission is generated by vehicles, as shown in Figure 12. Therefore, this study will focus on the effects of PM10 on human health. The process of this evaluation consists of three important steps as shown in Figure 13.
The methodology was used to estimate impacts of air pollutants as employed by Ostro (1994). The methodology that World Bank first introduced for Jakarta, is provide dose-response functions for the relationship between ambient particulate matter and several health problems, including mortality, respiratory hospital admission, emergency room visits, restricted activity days for adults, lower respiratory illnesses for children, asthma attacks, and chronic disease. A dose-response function is a formula to calculate the number of people that contract a certain health problem in a certain area, since these people are exposed to an air pollutant concentration above an air quality standard. Particulate matter dose-response functions utilized in this work are as follows:

(1) Death:
Number of death = 0.096 \times (PM10 – Standard for PM10) \times POP \times CM \quad (4)

PM10 = the current annual average ambient level of PM10 (μg/m³) in grid/area – assumption on reduction of PM10 obtained by cycling space development (μg/m³) in grid/area.
Standard for PM10 = the allowable PM10 annual average concentration. Typically, it is EPA standard or Indonesian standard
POP = population per grid/area, CM = Crude mortality rate for Jakarta (approximately 0.07)

(2) Respiratory Hospital Admission (RHA):
Number of RHA case = 0.000012 \times (PM10 – Standard for PM10) \times POP \quad (5)

(3) Emergency Room Visit (ERV):
Number of ERV case = 0.0002354 \times (PM10 – Standard for PM10) \times POP \quad (6)

(4) Restricted Activity Days (RAD):
Number of RAD case = 0.0575 \times (PM10 – Standard for PM10) \times POP \quad (7)
(5) Lower Respiratory Illnesses Children (LRI):
Number of LRI case = 0.00169 • (PM10 – Standard for PM10) • POP

(6) Asthma Attacks (AA):
Number of AA case = 0.0326 • (PM10 – Standard for PM10) • POP • AP
AP = percentage of asthmatic persons in the population (approximately 0.07).

(7) Respiratory Symptom Day (RSD):
Number of RSD case = 0.183 • (PM10 – Standard for PM10) • POP

(8) Chronic Bronchitis (CB):
Number of CB case = 0.0000612 • (PM10 – Standard for PM10) • POP

The annual average ambient level of PM10 (μg/m³) in grid/area and Indonesia’s standard for PM10 were based on Study Air Quality in Jakarta from Asian Development Bank Report (2002). To quantify the economic value of several health problems above, the Cost of Illness (COI) was used as a method, which the basic estimating of cost will come from Cipto Mangunkusumo and UKI Hospital Jakarta (ADB Report, 2002) as representatives of public hospital, as shown in Table 5.

Table 5 Indicators, number of cases and value of air pollution

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Area</th>
<th>Effects of air pollution</th>
<th>Number of cases (in cases)</th>
<th>Value of risk*** (in US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid of area*</td>
<td>T. Abang</td>
<td>Death</td>
<td>165</td>
<td>10,239</td>
</tr>
<tr>
<td>Population of grid (1,000people)*</td>
<td>140.8</td>
<td>Restricted Activity Days (in 1,000 cases)</td>
<td>141</td>
<td>1.9</td>
</tr>
<tr>
<td>Ambient level of PM10(μg/m³)*</td>
<td>107.9</td>
<td>Hospital Admission</td>
<td>29</td>
<td>91</td>
</tr>
<tr>
<td>Reduction of car's PM10</td>
<td>0.18</td>
<td>Emergency Room Visits</td>
<td>579</td>
<td>15</td>
</tr>
<tr>
<td>Reduction of motor bike's PM10</td>
<td>0.12</td>
<td>Asthma Attacks</td>
<td>5,610</td>
<td>2.7</td>
</tr>
<tr>
<td>Standard for PM10(μg/m³)**</td>
<td>50</td>
<td>Lower Resp. Illnesses</td>
<td>986</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Respiratory Symptoms (in 1,000 cases)</td>
<td>450</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chronic Bronchitis</td>
<td>150</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
** EPA standard for Indonesia based on annual arithmetic mean.
***Based on Cipto Mangunkusumo and UKI Hospital, as representative public hospital.

4.3.4 Benefit on Travel Time (ΔBtt)
In general, cycling speed can be related mainly to the length and type of facilities. The speed also based on personal, segment-specific and/or trip characteristics. The personal factors are due to differences between individual-level characteristics, which include gender, age, and comfort with traveling in various types of traffic. It also includes the time of day when the trip was made. Segment characteristics that might be affecting travel speed include the number of signalized intersections and the average daily traffic along the segment. However, a comprehensive literature review examines that majority cycling speed in general between 6.2 mph (10 km/h) and 17.4 mph (28 km/h). A study of bicycle in the Netherlands used a mean speed of 11.2 mph (18.0 km/h) to develop service flow rates for bicycles. Another study conducted by Thompson, D., et al. (1997) found that the mean speed of all ages was around 9.2 mph (14.8 km/h).

On the other hand, cycling speeds can be different according to type of facilities. Typically, there are three types of environments for cyclists. First is the off-street facility which is dedicated the space for cycling only (although sometimes for cycling and walking). In this case, the interaction with traffic is minor or non-existent. The sample of this type is the ordinary sidewalk. Second is the on-street facility on which cyclists travel to the side of regular traffic, because there are not yet any dedicated lanes where they have the right of way.
Third is the regular street which has the highest level of interaction between cyclists and traffic. Cyclists must travel in mixed traffic. Predicting bicycle speed using GPS data developed by Geneidy (2007) showed that cyclists traveling on off-street facilities move faster than all the other facilities when keeping all other variables at the mean value. The average speed along off-street facilities may be around 10.1 mph (16.25 km/h), on-street facilities is slightly lower at 9.71 mph (15.62 km/h), and for cyclist on regular streets may be 9.79 mph (15.75 km/h).

There is the high possibility that cycling space in Jakarta will be developed in ordinary sidewalk (Jakarta Traffic Management Centre, 2009). If we assume average travel speed in Jakarta is 11.7-20.3 km/hour during the peak hour on heavy congestion (Trans Jakarta Busway, 2008), it is possible to consider that travel times for shifting from motor vehicle to cycling will stay unchanged. Compared to use car and motor bike in the road, travel time will be probably same or a longer while using bicycle on ordinary sidewalk. In order to not over estimates, we have assumed that the benefit on travel times for cyclists is not identified.

4.3.5 Benefit on Parking and Vehicle Cost (ΔBpc, ΔBcc) and Enjoyment-Security (ΔBsc)

The benefits on parking cost, vehicle cost and user’s enjoyment-security were calculated as follows.

1) Benefit on parking cost was quantified through daily user’s experience. We questioned respondents if they change the current motor vehicles to bicycle, how much will save the money for parking cost every day. The average of parking cost was estimated as 9,317 – 13,016 Rupiah (1 – 1.4 US$) respectively.

2) Vehicles Cost consists of costs for fuel, maintenance and spare parts. The benefit was quantified through the question; if respondents change their modes from current motor vehicles to bicycle, how much they will save money for vehicles cost per months. The result shows that the average fuel cost for car driver is 363,200 – 555,800 Rupiah (40.3 - 61.7 US$) and 270,600 – 437,900 Rupiah (30 – 48.6 US$) for motor bike driver per month.

3) Enjoyment and security are two important factors and can not to be separated. To enjoy cycling activities, a security environment and area are urgent factors. Therefore, in order not to overestimate, we assumed that this factor is one term. The calculation was based on method of WTP for respondents who will shift their modes from motorized vehicles to cycling. Based on the literature review, it is known that about 10 % income of Jakarta’s residents is spent for recreational, hobbies and enjoyment activities. Within the value limit above, respondents were asked how much they were willing to pay for improvement of enjoyment and security on cycling every year. The results of calculated benefits are not small as shown in Table 6.

<table>
<thead>
<tr>
<th>Category of benefits</th>
<th>Yearly cost from car to cycling (in million Rp)</th>
<th>Yearly cost from motor bike to cycling (in million Rp)</th>
<th>Value of benefits (in billion Rp)</th>
<th>Value of benefits (in million US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel cost</td>
<td>1.5 - 2.3</td>
<td>1.8 - 2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Cost</td>
<td>0.6 - 1.4</td>
<td>1.1 - 1.9</td>
<td>472 - 755</td>
<td>52.4 - 83.8</td>
</tr>
<tr>
<td>Spare parts, etc</td>
<td>0.9 - 1.6</td>
<td>0.9 - 1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking charge</td>
<td>0.12 - 0.17</td>
<td>0.10 - 0.13</td>
<td>120 - 173</td>
<td>13.3 - 19.2</td>
</tr>
<tr>
<td>Security and Enjoyment</td>
<td>0.08 - 0.18</td>
<td>0.05 - 0.11</td>
<td>106 - 237</td>
<td>11.7 - 26.3</td>
</tr>
</tbody>
</table>

The USD-IDR conversion in 2010, USD 1 = IDR 9,000.
4.4 Total Benefit (ΔBtot)

The results show that the total benefit is 85.3 – 138 million US$, which benefit on vehicle cost saving holds the major share contributed approximately 60 percents of total benefit as shown in Figure 14. One important to note here, the quantifying is based on a limited knowledge of many of information. The main reason is the lacking of previous studies, research and updated data available for Jakarta or Indonesia’s standard. Therefore, some benefits are particularly hard to be valued. On this condition, although we have to use several consideration and assumptions, they might be realistic and evaluating reliable indicators and standards for Jakarta.

Figure 14 Benefit of cycling space development and sensitive analysis

In here, the sensitivity analysis should be considered for quantifying benefits of a project without established data available. The analysis includes the effects of uncertainties for the applied factors; (1) estimation for cycling demand, (2) estimation of health benefit, (3) the change in the number of accidents.

Firstly, the very high proportion of respondents who were willing to cycling might reflect such a propensity. The future cycling demand applied on this study was taken under a simple evaluation and upper estimation based on respondent’s answer. If we add one strict assumption that shifting to cycling is possible for respondents only with trips less than 10 kilometers, the total benefit is lower as demonstrated in Figure 14.

Secondly, we assumed that new active cyclists and regular pedestrians with aged over than 30 would be affected, as mentioned above. When assume the strictly level with limit aged over than 40, benefits of health will dropped 25 percents and total benefits will be lower than results in Figure 14.

Thirdly, the applied estimation on reduction of accidents was based on an estimation regarding the phenomenon and data sets in several countries. Therefore there is a possibility that reduction of accidents will be lower even higher than estimation. When we assume that the number of accidents decreased by less than 0.4, the benefits of improvements might be lower than estimation in Figure 14.
5. CONCLUSION

This study aims to quantify benefits of cycling space development if they are improved in Jakarta. Based on the feasibility of method, the Contingent Valuation Methods is chosen as bases for quantifying. Improvements on health, changes in the number of accidents, air pollution, saving on user's parking cost, time saving, vehicles cost savings and security - enjoyments were considered as benefits. Some benefits are particularly hard to be valued. On this condition, we have to use several consideration and assumptions, but realistic, through evaluating reliable indicators and standards for Jakarta. In here, the sensitivity analysis is considered to analyze the effects of uncertainties on the applied factors.

The results demonstrated a finding that NMT is one profitable measure and optimal solution against the rapid increasing of motor vehicles in Jakarta. The total benefit is 85.3 – 138 million US$ under condition that benefit on travel times for cyclists are not identified. Therefore, if a motor vehicles driver declares the willingness to change to cycling even if it would lead to a longer travel time, we can assume that the benefit on health and saving on costs connected to their choice, which benefit on vehicle cost saving holds the major share approximately 60 percent of total benefits. This is dependent on the higher interest to cycling still among large number of motorized vehicles in Jakarta. The value of total benefits might be higher, as some social impacts were not included on the quantifying. The value might also be lower with using strict level of estimation as reflected on the sensitive analysis. However, this study is designed to propose and discuss the applied framework of methodology for quantifying, and not interpreted as an exact values.

The main strength of study is there have been very few studies which evaluate benefits of cycling space if they are improved in Jakarta. Therefore the findings will be useful in the context of the current promotion of cycling in Jakarta. However, this study was done through the small size of respondents and location with simple evaluation of demand estimation. For the future, the findings could be developed to be more comprehensive evaluation and systematical trips demand estimation. To reach that, more knowledge and discuss will be needed for sufficient estimation, such as quantifying the effects of cycling facilities on road safety and model for valuations of health benefit.

REFERENCES


