ECONOMIC VALUATION OF AIR QUALITY IMPROVEMENT IN TRANSPORT SECTOR OF KLANG VALLEY, MALAYSIA: COMPARING THE CONTINGENT VALUATION METHOD AND CHOICE EXPERIMENT

BY

SARABDEEN MASAHINA

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ABSTRACT

Malaysia has experienced incredible economic achievement in the last three decades, which had activated urbanization and led to an increase in the per capita income of its population. This leads to rapid growth in transport sector. Due to rapid urbanization and rapid growth in transport sector, air quality is declining in some urban areas especially in Klang Valley Malaysia. As a consequence, Malaysian residents are suffering from many health problems. To address this issue, this study is trying to estimate the preferences of the household respondents towards air quality improvement in Klang Valley, Malaysia. The objectives of this study are to investigate the level of the households' knowledge, attitude, and behavior towards the environmental pollution and air pollution, to estimate the factors which affects the willingness to pay (WTP) of the respondents for improving the air quality in Klang Valley and to compare the WTP of the respondents obtained from contingent valuation method (CVM) and choice experimental design (CE) for air quality improvement in Klang Valley. CVM and CE are utilized to estimate the WTP. These methods consisted of asking people directly about their WTP extra fuel price to cover the costs of a new alternative air quality management project in Klang Valley, Malaysia. The survey results are analyzed using Binary Logit Model for CVM and Conditional Logit Model for CE. In this study, it is found that the level of knowledge of the respondents is high and the attitude of the respondents is positive, but the behavior of the respondents is low. The mean WTP derived from CVM is about RM 2.13 per respondent and the mean WTP for the new air quality management program derived from CE is about RM1.99 per respondent. So, this study reports that the respondents are willing to pay extra fuel price comparatively higher than current fuel price for air quality improvement in Klang Valley. This study further reports that number of sick days, air pollution index, medical expenditures, age, city, ethnicity, outdoor activities and respiratory symptoms are the significant variables which affects the WTP of the respondents. The results of the study also show that there is no significant difference between the WTP of the respondents for air quality improvement in Klang Valley derived from CVM and CE. The policy implication of this study is highly significant in this sense that if the household respondents are willing to pay extra fuel price, the government can reduce the subsidy on fuel price and they can use that money for the development of transport sector in Malaysia. This study presents the household respondents' preferences about government policy to improve the air quality improvement in Klang Valley. The results of this study also suggest that both CVM and CE could be successfully implemented for environmental valuation in Malaysia.

ملخص البحث

شهدت ماليزيا إنجازات إقتصادية لا تصّدق في العقود الثلاثة الماضية. الشئ الذي أنشط المناطق الحضرية وأدى إلى زيادة في دخل الفرد من السكان. و هذا قد أدى إلى النمو السريع في قطاع الموصلات. بسبب هذا النمو السريع في المناطق الحضرية و قطاع الموصلات فقد تدنت نوعية الهواء في بعض المدن خاصة في منطقة كلانج فالي بماليزيا. نتيجة لذلك, فكثير من سكان ماليزيا يعانون من بعض المشاكل الصحية. تحاول هذه الدراسة علاج هذه المسألة بتقدير كيفية تفضيل الأسر لتحسين نوعية الهواء في ماليزيا. وبالتالي فإن أهداف هذه الدراسة التحقيق في مستوى المعرفة و مواقف و سلوك الأسر تجاه التلوث البيئي و التلوث الجوي بتقدير العوامل التي تؤثر على قابلية الدفع(WTP) من المستطلعين لتحسين نوعية الهواء في كلانج فالي والمقارنة بين رغبة المستطلعين في الدفع التي تم الحصول عليها من CVM و CE لتحسين نوعية الهواء في كلانج فالي. تستعمل طريقة التقييم الاحتمالي (CVM) و تصميم الخيار التجريبي(CE) لتقدير الاستعداد للدفع. تتألف هذة الاساليب بسؤال الناس مباشرة من مدى استعدادهم لدفع إضافي في سعر المحروقات لتغطية تكلفة مشروع جديد لإدارة بديلة لنوعية الهواء في كلانج فالي, ماليزيا. تم تحليل النتائج بستحدام ثنائي اللوغاريثمي (Binary Logit) لنموذج (CVM) و اشتراطي الوغاريثمي (Conditional Logit) لنوذج (CE). تبين في هذه الداسة بأن مستوى معرفة المستطلعين عالي و لديهم موقف إيجابي ولكن سلوكهم منخفض. وأن متوسط الاستعداد لدفع التي تم الحصول عليه من (CVM) هو حوالي 2.13 رنجت ماليزي للمستطلع الواحد وأن متوسط الاستعداد للدفع لمشروع إدارة نوعية الهواء التي تم الحصول عليه من ال (CE) هو حوالي 1.99 رنجيت ماليزي للمستطلع الواحد. و بذلك فإن تقارير هذه الدراسة تظهر بإن المستطلعين المستعدين لدفع أسعار المحروقات الإضافية أعلى نسبيًا من أسعار المحروقات الحالية و ذالك لتحسين نوعية الهواء في كلانج فالي. تظهر تقارير الدراسة أيضًا بأن عدد أيام المرض و مؤشر تلوث الهواء و النفقات الطبية و العمر و المدينة و المجموعة العرقية و الانشطة التي تتم خارج المنزل و أعراض الجهاز التنفسي هي من العوامل المهمة التي تؤثر تأثير إجابي على رغبة المستطلعين للدفع . تشير النتائج أيضًا بأنه لا يوجد فرق كبير بين رغبة المستطلعين للدفع لتحسين نوعية الهواء في كلانج فالي بين CVM وCE. السياسة الضمنية لهذه الدراسة هي هامة للغاية و هي بأن قابلية الأسر المستطلعة لدفع زيادة في أسعار المحروقات يمكن الحكومة من تقليل الدعم لأسعار المحروقات و الإستفادة من تلك الأموال في تطوير قطاع الموصلات في ماليزيا. تقدم هذه الدراسة تفضيل الأسر التي تم إستبيانها لسياسة الحكومة لتحسين نوعية الهواء في كلانج فالي. كما تشير نتائج هذه الدراسة أيضًا إلى إمكانية إستعمال كلًا من CVMوCE بنجاح لتقييم البيئة في ماليزيا

APPROVAL PAGE

This dissertation of Sarabdeen Masahina has been approved by the following:

_____
Rafia Afroz
Supervisor

_____
Fardaus Alom
Inernal Examiner

_____
Mad Nasir Shamsudin
External Examiner

_____
Keisuke Hanaki
External Examiner

_____
Sohirin Mohammad Solihin
Chairman

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Sarabdeen Masahina

Signature ..... Date .....

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Affirmed by Sarabdeen Masahina

Signature ..... Date .....

To my father, Sarabdeen M. H and my mother, Ummu Jameela

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LIST OF ABBREVIATION

AEM	Averting Expenditure Method
APEEP	Air Pollution Emission Experiments and Policy Model
API	Air Pollution Index
ASC	Alternative Specific Constant
BID	Biding Amount (Monetary Value)
CE	Choice Experiment
CI	Confidential Intervals
CLIM	Conditional Logit Interaction Model
CM	Choice Modelling
CR	Contingent Ranking
CRt	Contingent Rating
CSU	Compensating Surplus
CVM	Contingent Valuation Method
DC	Dichotomous Choice
DOE	Department of Environment
EC	Environmental Consciousness
EPU	Economic Planning Unit
ESU	Equivalent Surplus'
FGD	Focus Group Discussion
GEN	Gender
HIC	Household Income
HK$	Hong Kong Dollor
HPM	The Hedonic Pricing Model
IEA	World Energy Statistics
ME	Medical Expenditures
ML	Maximum Likelihood
NSD	Number of Sick Days
OA	Outdoor Activities
PAPA-SAN	Public Health and Air Pollution in Asia-Science Access on the Net
PC	Payment Card
PC	Pair-wise Comparisons
PV	Payment Vehicle
RM	Ringgit Malaysia
RS	Respiratory Symptoms
RUT	Random Utility Theory
SCLM	Simple Conditional Logit Model
TCM	Travel Cost Method
TEV	Total Economic Value of Environmental Quality
USA	United States of America
USEPA	United States of Environmental Protection Agencies
VSL	Value of a Statistical Life
WHO	World Health Organization
WTA	Willing to Accept
WTP	Willingness to Pay

LIST OF SYMBOLS

CO	Carbon Monoxide
CO_2	Carbon Dioxide
ε_{ij}	unobservable components
NO_2	Nitrogen Oxide
O_3	Monoxide
PM_{10}	Particulate Matter
SO_x	Sulfur Oxide
Vij	observable components
Y_{NW}	Non-wage income
$\mu g/m^3$	Micro gram
Mm	Micrometers

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

The past two decades have perceived a noteworthy boost in research on the effects of air pollution on public health in developing and developed countries of the world. The findings of those research show that exposure to outdoor air pollution has direct link to a broad range of sensitive and chronic health effects. The health effects range from minor sickness to death (Ostro, 1994; Groosman et al., 2009; Quah and Boon, 2002; Muller, 2007; Ribeiro and Cardoso, 2003; Currie et al., 2009; Samakovlis et al., 2005; Evens and Smith, 2005; Pope and Dockery, 2006). Besides the health effects, air pollution damages building structures, agricultural crops, vegetation, forests and reduces visibility. Global warming and ozone depletion are also caused by air pollution (Muller, 2007).

The report of United Nations Environmental Program confirms in 2000 that 1.1 million people are breathing unhealthy air, and exposure to urban air pollution grounded almost two thirds of the estimated 800,000 deaths and 4.6 million people lost years of healthy life worldwide (World Health Organization, 2004). The air pollution health effects raise concern about respiratory diseases in many locations of developing countries such as China, India, Malaysia, Hong Kong, and Thailand (World Bank, 1997; Hughes and Lovei, 1999, Ekpenyong et al. 2013). For instance, Hong Kong is facing severe human health problem due to air pollution (Bloomberg News, 2011). The estimated health cost for hospital admission and lost productivity for a year between 2007 and 2010 is about HK$ 21.2 billion, and caused 4800 human deaths (Bloomberg News, 2011). A report by the State Environmental Protection

Administration of China (SEPA, 2006) indicates that two out of every five cities in China could not maintain the residential area air quality standard which increases the risk of adverse human health effects.

Thus, air pollution affects society in many aspects. Attempts have been made to measure the cost-benefit of the air quality improvement by traditional means such as the dose–response method. This method is difficult to use to measure the monetary value for intangible goods. However, contingent valuation method (CVM) and choice experiment (CE), called as stated preference methods, are used to obtain a monetary value for an intangible good which does not have a market price. In order to measure the monetary value of air quality improvement, the CVM and CE can be used and these methods represent the consumers' hypothetical market and elicit their preferences for public goods. Thus, these methods can avoid the absence of a real market for public goods (Mitchell and Carson, 1989). It can also measure the effect of socio economic factors of individuals on the monetary valuation of public goods.

1.2 STATEMENT OF THE PROBLEM

Malaysia is one of the newly industrialized countries which is developing rapidly with the aim of achieving a developed country status under Vision 2020 (Bank Negara Report, 2013). Malaysian economy has shifted from agricultural-based economy to a largely manufacturing-based economy. Consequently, Malaysia has experienced incredible economic achievement in the last three decades, which had activated urbanization and led to an increase in the per capita income of its population (Bank Negara Report, 2013). Rapidly increasing economic activities and rising income levels has led to an exponential increase in the demand for both freight and passenger transport services in the country, especially in the rapidly growing urban areas.

However, there are claims about public transport sector in Malaysia such as the lack of service quality (Almselati et al., 2011), late bus arrival, increase in travelling time and travel cost (Kamba et al., 2007; Nurdden et al., 2008). Another claim about using the public transport is that passengers are stuck in traffic jams thus waste their time (Beirao and Cabral, 2007). Therefore, most people wish to have their own vehicles because of the degree of freedom and accessibility such vehicles allow them. They also have a passion for cars and driving, for comfort, and they have negative perception on public transport (Steg, 2005; Beirao & Cabral, 2007).

According to the Ministry of Transport, the total number of registered vehicles is continuously increasing in Malaysia. Apparently the number of registered vehicles increased from 7,686,684 to 19,016,782 from 1996 to 2009 (Ministry of Transport, 2010) of the total number of registered vehicles in Malaysia in 2009 and 8,506,080 were private passenger cars. This condition has led the land transport sector, among the other sources such as power plant, industry and open burning, to be a prominent sector for the source of air pollution in Malaysia for the last 13 years (Malaysia Environmental Quality Report, 2012).

The transport sector increases the pollutant (Carbon Monoxide [CO], Particulate Matter [PM_{10}], Nitrogen Oxide [NO_2] and Sulfur Oxide [SO_x]) level in the air. In Malaysia, the transport sector was contributing approximately 97% of CO, 18% of PM_{10}, 52% of NO_2, and 7% of SO_x, from 1991 to 2012 in three years interval (DOE, 2012). Figure 1.1 shows the trend of the air pollution level from transport sector in Malaysia. This figure shows a fluctuating trend of CO, PM_{10}, SO_x, and NO2.

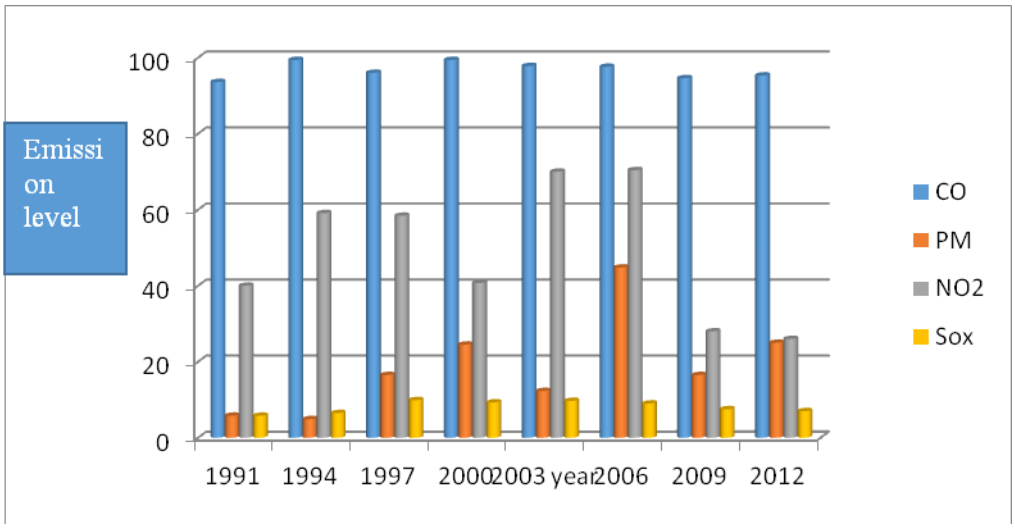

Figure 1.1 The Trend of Air Pollution Level from Transport Sector in Malaysia (from 1991 to 2012, in Percentage in Three Years Interval)
Source: Developed from DOE Environmental Quality Data Reports

Transport sector was identified also as the fastest growing source of carbon dioxide (CO_2)[1] emissions (Ribeiro et al., 2003). As shown in the World Energy Statistics (IEA, 2007), the total CO_2 emission increased 17.35 % from 2000 to 2003 in Malaysia whereas, it increased by 6.82 % in the whole world and 14.22 % in Asia during the same time period. Table1.1 displays the level of total CO_2 emission in Malaysia, Asia and in the whole world in 2000 and 2003. In Malaysia, the total CO_2 emission increased more than the global average and Asian average from 2000 to 2003.

[1] "Carbon dioxide is formed from one molecule of carbon and two molecules of oxygen whereas carbon monoxide is formed from one carbon atom bound by oxygen atom. Whereas carbon dioxide is formed as a result of combustion of carbon containing compounds, carbon monoxide is formed as a result of partial combustion of carbon containing compounds. Carbon dioxide is denser than air while carbon monoxide is lighter than air" (http://www.ask.com/question/what-is-the-difference-between-carbon-dioxide-and-carbon-monoxide).

Table 1.1 Total CO_2 Emission Levels (in million metric tons)

Destination	2000	2003	% in Increase
World	23,832.70	25,575.99	6.82%
Asia(without Middle- East)	7,272.53	8,477.95	14.22%
Malaysia	116.19	140.95	17.35%

Source: IEA (2007)

Report from the Department of Environment Malaysia (2003) shows that Klang Valley was the region most prone to serious air pollution compared to other parts of the country. With mountains at the east and the Straits of Malacca at the west, and being highly developed and densely populated, the Klang Valley provided a conducive environment for pollutants to accumulate particularly when atmospheric conditions are stable. For this reason, it was given a serious concern after recognizing that it had a high potential for air pollution due to its inherent topography (Sham, 1979). A study undertaken by the Klang Valley Environmental Improvement Project in 1987 reported that the total air pollution emission level in Klang Valley was about 433,400 tons per year (Department of Environment (DOE), 1988).

In order to monitor the air pollution emissions in Klang Valley, the Division of Environment Malaysia carried out the first air quality monitoring in 1977. The air quality monitoring was divided in to two phases; the "early years" (1978-1982) and the "later years" (1983 onwards) (Zainal Abidin et al., 1988 cited in Afroz et al., 2004). The first long term air monitoring was carried out in 1978 at an industrial and residential zone; Petaling Jaya in Klang Valley. The result of PM_{10} and SO_x in air quality monitoring showed that PM_{10} exceeded by 93% at the industrial zone and 95% at the residential zone than the proposed standard (a 24- hours average of 0.1 for industrial zone and 0.05 for non-industrial zone). The CO level was also over the proposed standard. In the later years, the level of air quality declined by 50% of the

proposed standard for PM_{10} (24 hours average of 0.075) during 1981-1983 period. But, the level of SOx was lower than the proposed standard. However, it is obvious that PM_{10} is still a major problem faced by Klang Valley (DOE, 1980-1985).

As the levels of PM10, CO, SOx are above the proposed standard level in Klang Valley, the number of unhealthy days increased. Unhealthy days refers to the overall number of increasing days that a person is not good physically or mentally until recent days (David et al., 2003). The Klang Valley experienced relatively more unhealthy days compared to other locations in Malaysia. Table 1.2 presents the trend of unhealthy days in Klang Valley from 2001 to 2009.

Table 1.2 The Trend of Unhealthy Days in Klang Valley, 2001-2009

Location	2001	2002	2003	2004	2005	2006	2007	2008	2009
Shah Alam	19	67	56	88	60	47	23	44	41
Kajang	37	17	34	41	44	34	24	11	15
Kuala Lumpur	11	30	28	63	67	5	19	24	24
Klang	7	50	12	11	33	14	2	8	16
Petaling Jaya	4	0	9	17	20	12	2	1	10
Kuala Selangor	8	21	0	2	13	4	0	0	10
Putra Jaya	0	0	1	1	22	30	13	13	7
Batu Muda	0	0	0	0	0	0	8	0	21
Total	93	185	140	223	259	146	91	101	144

Source: Department of Environment (DOE), 2010

As illustrated in Table 1.2, the number of unhealthy days experienced by Klang Valley was 93 days in 2001 and it increased to 185 days in 2002, which was more than double that of 2001. In 2003, unhealthy days declined to 140 days. Then again, it increased greatly to 223 days and 259 days in 2004 and 2005, respectively. In the

following two years; in 2006 and 2007, it declined to 146 days and 91 days, respectively. Then, the unhealthy days increased in 2008 and 2009.

The report from the Department of Environment Malaysia indicates that Shah Alam, Kajang, Kuala Lumpur, and Klang experienced the highest number of unhealthy days in 2009 whereas Petaling Jaya, Kuala Selangor and Putra Jaya experienced medium number of unhealthy days and Batu Muda experienced the lowest number of unhealthy days within Klang Valley (DOE, 2010). The DOE report further indicates that the reason for the unhealthy air quality for about 70% of the days in the Klang Valley in 2002 was due to high level of respirable particulate matter (PM_{10}) while the remaining 30% was due to high ozone levels. This condition affects the human health in this area.

Existing studies found that respiratory diseases were among the highest ranked diseases suffered by Malaysian citizens due to the air pollution (Afroz et al., 2004, Jamal et al., 2004). The report of a survey conducted in Klang Valley in 2004 stated that approximately 49% of diseases were air-pollution-related. Out of the 49% of air polluted diseases; allergy due to dust or pollen covers for 20%, asthma 14%, heart disease 12% and Chronic Bronchitis 3% (Afroz et al., 2004). It was predicted that the emission load from vehicles in 2015 would be increased between 2 and 3 times higher than emission loads in 2005[2] (RPR, 2009). Thus, air pollution related diseases might be increased by 2 to 3 times in 2015 compared to 2005. When it comes to the age group most affected by the air pollution, the elderly and the children were the most vulnerable of the effects of PM_{10} (Environmental Protection Agency, 1996; WHO, 2002). Hence, consideration of the human health effects should be given more

[2] Since the emission levels are estimated from the energy consumption, the author predicted the emission level approximately from the projected energy demand using the data from ERIA Research Project Report, 2008.

emphasis in policy discussion on air quality, in particular, and the environment in general.

To date, a few studies have been carried out to estimate the WTP of consumers for improved environmental quality in Kuala Lumpur and Petaling Jaya using contingent valuation method (Wang, 1997; Zailina et al., 1997; Jamal, 2002; Pek and Jamal, 2010; EPU, 1998). The reason why this current study is important is that it could assist policy makers to formulate relevant policies and laws. It is note worthy to mention here that public's knowledge, awareness, and WTP for the improvement of the local environmental quality are not the focus of the existing studies when in actual fact these play a vital role in the implementation of the legislation introduced by the government. For this reason, if the Malaysian government wants to implement effective policies to improve the air quality in Klang Valley, taking into consideration of the willingness of the consumers is essential. Otherwise, government policies cannot be efficiently put into practice. Therefore, with the possibility of an existing information gap, there is an urgent need to investigate the knowledge, attitude, behavior of households and their WTP to improve the air quality in Klang Valley.

Another gap is due to the methodology used. The existing studies conducted in Malaysia have so far solely relied on CVM estimation. Diamond and Hausman (1993) stated that many studies which employed the CVM faced problems such as inadequate scenario design and sampling technique of CVM. Another disadvantage of using this approach is that it depends on the precision of information and wrong information could not be changed after the fact is discovered. The CE approach, on the other hand, depends on the presentation of a choice situation using an array of attributes. Thus, it depends less on the precision and unity of any fussy description of the good or service. Therefore, respondents are asked their preferred alternative from a 'choice set' made