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RESIDENTS' PREFERENCES ON ATTRIBUTES OF URBAN AIR QUALITY IMPROVEMENT IN PETALING JAYA, SELANGOR, MALAYSIA

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Abstract: Petaling Jaya, as a core hub of the Klang Valley and a leading development centre in Selangor, has a heavy carbon footprint from mobile sources. As a result, this study identifies residents' attitudes toward air emissions, their preferences for improvement, and measures the marginal importance of the attributes for improving urban air quality. 300 residents from four zones; Seksyen, SS, PJU, and PJS were selected using stratified and systematic random sampling method. They were evaluated on their attitudes using a Likert scale and preferences using a discrete choice experiment. According to descriptive analysis, respondents favour driving to using public transportation, but their overall attitude toward mitigating air emissions is favourable. Residents embraced an increase of 70% in carpooling initiative participation, 70% in indoor planting programme participation, four low emission zones, and six electric buses, according to the results of a random parameter logit model for the choice experiment. Based on 194,205 households, the marginal willingness to pay the value in PJ was calculated to be about RM33/household/month to RM6, 408,765.00/month in 2019. Residents would place a higher priority on environmental concerns if air quality improved. As a result, attempts to increase air quality may function as a benchmark for all urban cities.

Keywords: Air quality, air pollution, choice experiment, logit model, willingness to pay.

Introduction

Air pollution is a global issue that has a significant impact on the environment and human health. According to the World Health Organisation (2016), poor air quality causes 7.6% of global deaths each year. As a result, it has been identified as the world's most pressing environmental health risk, particularly in developing countries (Wey & Huang, 2018). Urban air pollution is a serious problem that affects developing countries more than developed ones (Chin *et al.*, 2019). Ghorbani *et al.* (2011) also noted an increase in urban air pollution in Iran's major cities and surrounding countryside. The effects were discovered to be greater in more densely populated areas.

Malaysia, like other developed countries, has undergone rapid urbanisation, industrialisation, and economic development, which has resulted in a decline in air quality (Chin *et al.*, 2019). The dramatic growth in Malaysian population from 31.19 million (2015) to 32.6 million (2019) resulted in an increase in the amount of registered vehicles from 26.3 million (2015) to 30 million (2018), and this figure is projected to grow more (Ministry of Transport, 2019). The number of automobiles rose by 0.10% (47.26% in 2017 to 47.36% in 2018). Whereas the number of buses decreased by 0.01% (0.21% in 2017 to 0.20% in 2018), reflecting a drop in public transportation (Ministry of Transport, 2019). According to the Malaysian Air Quality Guidelines, the transportation industry accounts for 87.8% of carbon emissions, mostly from mobile sources. According to projections, this number could triple by 2030 (Ghadimzadeh *et al.*, 2015).

The transition from rural to urban development in the Klang Valley (an urban conurbation containing one-third of Malaysia's population) has resulted in higher levels of urban air pollution (Abdul Halim *et al.*, 2018; Bazrbachi *et al.*, 2017). Malaysia's capital, Kuala Lumpur, as well as several neighbouring cities (Putrajaya, Klang, Shah Alam, Petaling Jaya, Kajang, Sepang, Subang Jaya, Selayang and Ampang Jaya), are located in this area. Despite open burning and manufacturing operations, the automotive industry is the most significant contributor to hazardous emissions among the three main sources of air pollution (Bazrbachi *et al.*, 2017). Indeed, the increased usage of motor cars in metropolitan areas triggers severe traffic (Abdul Halim *et al.*, 2018), which is only likely to escalate as car ownership increases (Zhang *et al.*, 2019).

Petaling Jaya (PJ) is a leading development centre in Selangor and serves as the Klang Valley's central hub (Petaling Jaya City Council, 2020). PJ's population was formerly 199,100 (2015) but has now risen to 752,449 (2019) and is projected to rise further in the coming years (Department of Statistics Malaysia, 2019). Regrettably, baseline data on the number of registered vehicles is frequently collected only at the state level. According to the data, the number of private motorcars in Selangor increased by 10,565 units between 2016 (1,151,577 units) and 2018 (1,171,190 units). The population of the Klang Valley is projected to grow from 4 million in 2016 to more than 7 million by 2020 (Ministry of Transport, 2017). According to the PJ city council, the city is strategically connected with other cities in the Klang Valley, resulting in high rates of congestion during peak hours, implicitly proving the statement of Leh *et al.* (2014) that PJ experienced a high level of road traffic (> 300,000 vehicles) in just 16 hours. Furthermore, carbon monoxide (CO) is the most prevalent pollutant from mobile sources in PJ, accounting for 73.35%, led by PM10 (17.40%), NO2 (9.17%), and PM2.5 (0.08%) (Mohamad *et al.*, 2018).

Furthermore, comprehensive data on pollution emissions for cities are scarce *(Chin et al.*, 2019); in this context, data on the residents' attitudes towards air pollution in Petaling Jaya are limited. Pertinently, the current scenario for improving air quality in a given city has been revised. Therefore, the objectives of this study included: i) to determine the attitude of PJ residents toward air pollution, ii) to determine residents' preferences on urban air quality improvement, and iii) to estimate the value of urban air quality improvement attributes in PJ. This study may serve as a benchmark for Malaysia's cities seeking to improve air quality.

Literature Review

Random Utility Theory

To be more specific, the random utility theory, also known as RUT, is the ideal theory to represent the foundation of choice experiments (CE) (Selassie, 2006).Much later in other fields such as environmental disciplines, was the RUT consciously introduced (Hanley *et al*., 2001). The RUT can be used in CE to model choices as a function of attributes and attribute levels, especially when respondents are asked to choose their most preferred option from a collection of alternatives, which are then focused on options that have the capacity to optimise utilities (Hess *et al*., 2018; Selassie, 2006). As a result, it is presumed that a certain degree of randomisation is given to persons who must decide dependent on the attributes of the alternate alternatives (Selassie, 2006). While it is possible to determine preferences indirectly, RUT argues that the benefit gained by individuals by their choices is not explicitly observable (Batley, 2008).

In terms of model specifications centered on utility theory, the CE, on the other hand, shares a common theoretical framework with the dichotomous preference contingent valuation method (CVM) in the RUM, as well as a common empirical analysis basis in limited dependent variable econometrics (Hess *et al.*, 2017; Hanley *et al*., 2001). According to this framework, the indirect utility function for each respondent i (U) can be decomposed into two parts: a deterministic element (V), which is typically specified as a linear index of the attributes (X), of the j different alternatives in the choice set, and a stochastic element (e), which represents unobservable influences on individual choice. This is shown in Equation 1.

$$U_{ij} = (V_{ij})(X_{ij}) + e_{ij} = bX_{ij} + e_{ij} \ldots\ldots\ldots\ldots \quad (1)$$

Thus, the probability that any particular respondent prefers option g in the choice set to any alternative option h can be expressed as the probability that the utility is associated with all other options, as stated in Equation 2.

$$P\,[(U_{ig} > U_{ih})\, V_h \neq g] = P\,[(V_{ig} - V_{ih}) > (e_{ih} - e_{ig})] \quad (2)$$

In order to derive an explicit expression for this probability, the distribution of the error terms (e_{ij}) must be identified. A typical assumption is that they are independently and identically distributed with an extreme-value (Weibull) distribution as shown in Equation 3:

$$P\,(e_{ij} \leq t) = F\,(t) = \exp\,(-\exp\,(-t)) \ldots\ldots\ldots\ldots \quad (3)$$

The specification above, termed as the conditional logit model (CLM), is a distribution of the error terms implying that the probability of any particular alternative g being chosen as the most preferred can be expressed in terms of the logistic distribution stated by McConell *et al*. (2012) in Equation 4.

$$P(U_{ig}) > U_{ih}, V_h \neq g = \frac{exp(\mu V_{ij}) \atop s}{\sum_j^s exp(\mu \cdot V_{ij})} \ldots\ldots(4)$$

Where, μ is a scale parameter inversely proportional to the standard deviation of the error distribution. Often, this parameter cannot be separately identified, therefore, is typically assumed to be one. In this regard, an important implication of this specification is that selections from the choice set must obey the Independence from Irrelevant Alternatives (IIA), which states that the relative probabilities of two options being selected are unaffected by the addition or removal of other alternatives. This property is derived from the independence of the Weibull error terms across the different options contained in the choice set. This model can be estimated using conventional maximum likelihood procedures, with the respective log-likelihood function stated in Equation 5 below, where y_{ij} is an indicator variable that takes a value of one of the respondents i choosing option j and zero, otherwise.

$$\log L \sum_{i=1}^{N} \sum_{j=1}^{J} y_{ij} \left\{ \frac{exp(V_{ij}) \atop {s \atop s}}{\sum_{j=1}^{j} exp(V_{ij}) \atop d} \right\} \ldots\ldots\ldots\ldots \quad (5)$$

Socioeconomic variables can be included in choice set attributes in the X terms, but as they are constant across choice occasions for any given individual (e.g., income is the same when the first choice is made as to when the second is made), they can only be entered as interaction terms, i.e., interacted with choice specific attributes. In the CE applications, the entrance fee is included as one of the attributes related to park conservation and management in the set of choices. As a result, the changes in marginal willingness-to-pay caused by a change in one particular attribute, such as coefficient b_c, can be determined using the formula mentioned above.

Stated Preference Method

Figure 1 shows the family of stated preferences. The SP approach can be divided into two parts: CVM and Multi-Attribute Valuation (MAV). The elicitation technique CVM can be further divided into open-ended contingent valuation (CV) and referendum CV. The latter methods in the MAV are the Conjoint Analysis, which can be divided into the Contingent Rating and Paired Comparison, and the CM, which can be divided into the contingent ranking and CE methods.

The general idea of applying each stated preference is presented in (Appendix C). In terms of the utility model, the contingent rating and paired comparison utilise the deterministic type of model. On the other hand, the contingent ranking and choice experiment utilise the random utility model (Matějka & McKay, 2014). Likewise, the elicitation format differs, with the former methods utilising preference-based elicitation formation, and the latter employing the choice-based format. Concerning the CV

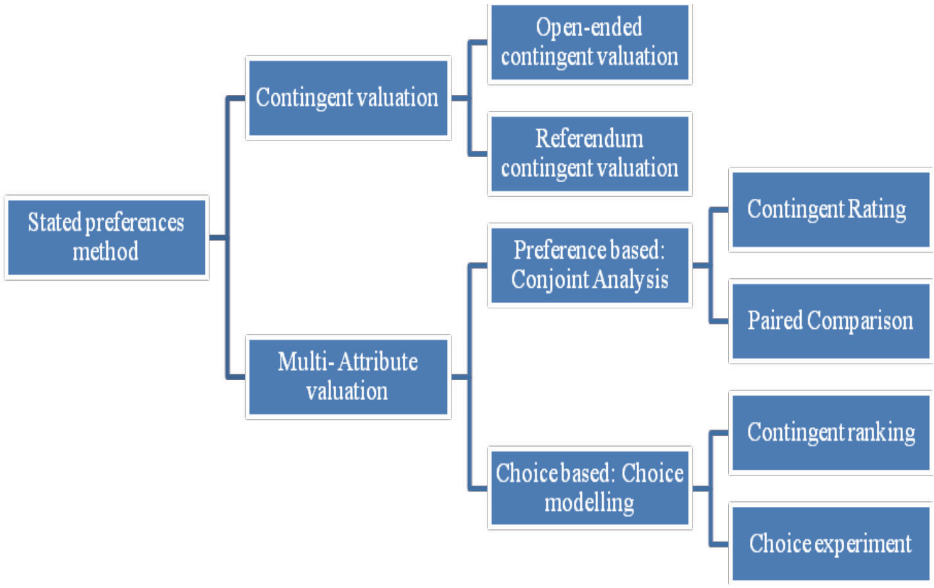

Figure 1: Stated preference techniques
(Source: Merino-Castello, 2003)

measurement scale, respondents were asked whether they were willing to pay for a pre-designed bid for environmental services. The measurement scale for other methods will be discussed in more depth in the following section with some examples. One of the most crucial bits of information retrieved from the table is the welfare estimates. CV, CE and contingent rating (CR) guarantee a welfare estimate, but the latter two must include a status quo option to be eligible.

Summary of Attributes from Choice Modelling Valuation Studies

The choice modelling approach estimates the non-use values in air pollution studies (Kaffashi *et al.*, 2015). It was based on random utility theory and the value characteristics theory, in which environmental goods were evaluated using assumed models to choose between different possible scenarios (Ghorbani *et al.*, 2011).

Previous studies on urban air quality improvement general attributes by Li and Hu (2018) four indicators were developed to measure people's behavioural intentions for improving air quality; two of these indicators were correlated with contingent valuation survey. Structural equation modelling (SEM, Bazrbachi *et al.* (2017) four indicators were developed to measure people's behavioural intentions for improving air quality; two of these indicators were correlated with contingent valuation survey. Structural equation modelling (SEM, Ndambiri *et al.* (2015) and Masahina *et al.* (2012) expressed concerns about health issues, poor public transportation efficiency, and increased in traffic congestion, as well as initiatives to reduce emissions, such as new technologies, engines, standards and improvements in public transportation. In this context, environmental policies on urban transportation planning are required to control the pollution rate *(Soria-Lara et al.*, 2019; Wey & Huang, 2018). Furthermore, countries' experiences and perspectives offer evidence and guidance for effective implementation. For instance, ride-sharing among choice travellers in Cape Town (Vanderschuren & Baufeldt, 2018), traffic restriction zones in Slovenia, advanced buses in Spain, driving restrictions in Beijing (Titos *et al.*, 2015), advanced green technologies and pollution treatment in China (Sun *et al.,* 2019), and a low emission zone in Germany (Schmitz *et al.*, 2018) have all proven successful at improving urban air quality.

Understanding stakeholders' preferences using a choice modelling method rather than a contingent valuation method is easier and more conducive as this technique does not ask respondents WTP questions and differs in terms of valuation scenario design *(Zahedi et al.*, 2019). For instance, most contingent valuation studies, respondents were asked how much they were willing to pay for the cause. In contrast, a valuation scenario design solicited preferred According to Ghorbani *et al.* (2011), using a choice experiment, people who lived in areas with poor air quality were more willing to pay some amount of money to reduce air pollution.

Despite the fact that several studies have focused on market and non-market valuations of ecosystem services, only a few have employed choice modelling in Malaysia, especially for environmental quality improvement valuation; this is the theoretical gap that this study tackled. To be more specific, few studies on improving urban air quality have been undertaken in Malaysia or any other urbanised areas. In terms of choice modelling, there have been several research that examined stakeholder expectations for air quality improvements. Kaffashi *et al.* (2016) proposed attributes based on existing literature, including the rate of unhealthy days and in-vehicle travel time. Ghorbani *et al.* (2011) emphasised the negative health consequences, elevated particulate counts, foul odours, and decreased visibility. There is proof that there are additional attributes related to the valuation of air quality enhancements in general.

In this context, a few differences were observed in the prevailing choice experiments conducted by Kaffashi *et al.* (2016) and Ghorbani *et al.* (2011) on air quality improvement as compared to this study. Kaffashi *et al.* (2016) suggested congestion fees (a pricing medium), general attributes focusing on the drive alone option, and a contrast of buses and trains (arrival frequency and comfort). On the other hand, Ghorbani *et al.* (2011) suggested green taxes, a cap-and-trade system, revenues from programmes and investment in infrastructure such as subways, electric cars and bicycle lanes (a pricing medium), attributes based on the environmental effects of air pollution, and comparisons between highly and moderately polluted areas. Therefore, identifying the value residents put towards environmental quality improvement is essential in this study.

Methodology

Study Site Description

Petaling Jaya, also known as PJ among locals, is a city in the Petaling District of Selangor, Malaysia. It is located at 3.1279° N, 101.5945° E and serves as the Klang Valley's central hub. The researchers selected this city to measure the overall air pollution impact caused by rapid urbanisation. According to the Department of Statistics Malaysia (2019), the population of PJ was 619,925 in 2018, and it increased to 752,449 in 2019. It is expected to increase, potentially having significant health and environmental impacts. As shown in Figure 2, here are four main areas: *Seksyen* (located in eastern PJ - 18.42 km^2), SS (located in central and western PJ - 17.60 km^2), PJU (located in northern PJ - 54.90 km^2), and PJS (located in southern PJ - 6.28 km^2).

Choice Experiment Design

An approach of selecting the best option for choice set attributes and price was to bridge the gap between public and government towards a more beneficial plan by stakeholders for the nation (Kamri, 2014). The most critical aspect of choice experiments is selecting the appropriate attributes. Relevant alternatives were selected based on purpose and frequency of usage to select the attributes. Before compiling the list of attributes, previous literature applicable to urban air quality enhancement was reviewed.

A focus group discussion (FGD) was conducted with relevant experts to ensure the study's policy relevance; respondents' preferences were shown in Table 1 (Flynn *et al.*,

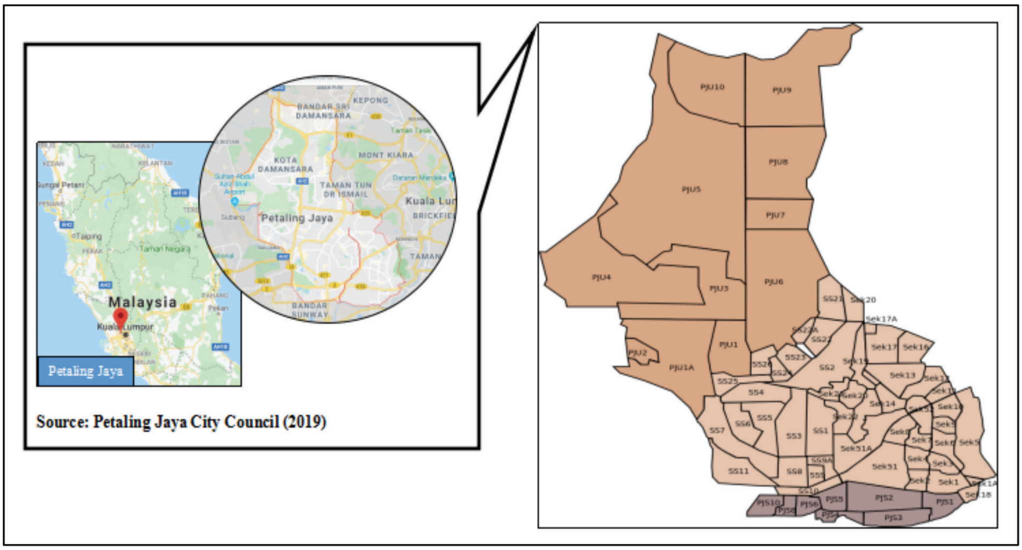

Figure 2: Map of Petaling Jaya, Selangor, Malaysia Google Map 2019 (3.1279° N, 101.5945° E)

Table 1: Expert-ranked transport mode choice attributes related to air quality improvement based on literature reviews

Air Quality Improvement Attributes	Academician	Road Transport Department (RTD) Enforcement Officer	Department of Environment (DOE)	Health Officer
Monitoring Technology	3	3	2	3
Low Emission Engine	4	5	4	4
Electric Buses	5	5	5	5
Traffic Management	4	3	4	3
Public Transport System	4	4	4	4
Road Infrastructure	2	2	2	2
Health Programme	2	2	3	3
Ride sharing Campaigns	4	4	4	4
R & D Projects	2	3	3	3
Pricing Medium	4	4	4	4

2018). The respondents included five academic experts: Two experts from Universiti Putra Malaysia, the RTD Enforcement Officer, DOE Officer and Health Officer. This discussion was essential in determining the most consistent attributes that would benefit management policy. Indeed, FGDs identify individual feedback and provide beneficial information (Kaffashi *et al.*, 2016). A 5-point scale was used ranging from [1] 'Strongly Disagree' to [5] 'Strongly Agree' to determine the essential attributes pertaining to urban air quality improvement in Petaling Jaya.

Attributes and Levels

Based on the highest rating, five main critical attributes (see Table 2) were shortlisted in the aspect of and its relevant attributes. The levels for each of the attributes were calculated following the Selangor State Structural Plan

2035, which was intended to improve air quality and FGD. According to the Selangor State Structural Plan 2035, PJ was one of 7,000 cities worldwide expected to engage in climate change reduction goals owing to excessive carbon emissions from mobile sources (Mohamad *et al.*, 2018). FGD was used to obtain quantitative and qualitative data (Kaffashi *et al.*, 2016) on their willingness to pay for air quality improvement, mostly to estimate the levels and price levels of the shortlisted attributes. Following that, a predetermined increment among the panels was suggested in this research to assess public feedback for a better improvement in PJ air quality.

To begin with, low emission zones (LEZ) are streets that only allow public transportation such as buses, taxis, and e-hailing vehicles because carbon emissions increase when there are more heavy-duty vehicles and private vehicles on the road. Based on the experts' review, the carbon emissions in PJ increased due to the high reliance on private transportation (Mohamad *et al.*, 2018), which has resulted in heavy congestion. Therefore, heavily congested areas or streets should be reserved merely for public transportation. According to the Road Transport Department (RTD), the implementation cost was determined by state budget allocation, and three levels were proposed in the choice card comprising 2, 4 and 6, which was the quantity of heavy traffic streets to limit traffic in order to reduce pollutions.

In addition to the low emission zone, electric buses (attribute 2), which emit less harmful pollutants, including carbon emission, than diesel buses, could be introduced (Schmitz *et al.*, 2018). Electric buses should be introduced as soon as possible to reduce urban air emissions (Titos *et al.*, 2015). As transitioning to electric buses is costly and time-consuming, the first stage begins with only two electric buses as a kick start.

Meanwhile, initiatives, such as the provision of carpool campaigns for leisure travellers, became the most effective tool for engaging the public with the government (Vanderschuren & Baufeldt, 2018). This effective measure illustrates lower participation among PJ residents, implying that further measures would be required to induce a degree of participation. It requires approximately 50% to 70% initiative levels to break the habit of driving alone, to reduce gasoline consumption and to lower costs benefit consumers.

Hands-on programmes, such as indoor gardening at home, are common, and it is an initiative that reflects advanced green technologies towards sustainability (Sun *et al.*, 2019). It is a programme designed to encourage PJ residents to reduce their exposure to the health impacts of air pollution. Planting plants on balconies and within houses reduces indoor pollution and carbon heat. However, due to budgetary constraints and limited living room, less individuals will partake in this activity. This measure anticipates a participation rate of 70 to 90%.

In the case of mode choice studies, a pricing medium is a compulsory option that must be used in order to enforce any of the generic attributes. PJ residents were reported to object the RTD's proposed congestion fee (Kaffashi *et al.*, 2016) for car commuters owing to the inevitable increase in living costs. The adoption of a congestion fee (which has been effectively introduced in Singapore) lowers traffic; but, owing to a lack of public support, it remains just a recommendation. The attributes in this study were to curb carbon emissions, thus, a carbon tax for PJ residents was proposed. A carbon tax, also known as a climate change tax or an environmental tax, is a charge levied on carbon dioxide emissions (Wong *et al.*, 2019). In such circumstances, several countries have implemented a consistent carbon tax programme with a long-term goal of compensating for negative environmental impacts by improving energy production and utilisation (Wong *et al.*, 2016). A few studies carried out previously have observed a decrease in carbon dioxide emissions in countries such as Singapore, Sweden, Brazil, South Africa, and China that have implemented carbon taxes (Yong, 2019). Based on previous

Table 2: Attributes and levels for choice experiment

Air Quality Improvement Attributes	Details	Current Condition	Future Condition	Policy Tool
Carbon Tax	The annual tax for improving air quality in PJ.	No Tax	No Tax, RM0 Additional Increment RM10 Additional Increment RM15 Additional Increment RM20 Additional Increment RM25 Additional Increment RM30	Tax may be raised to improve the PJ's air quality via efforts.
Low emission zone	Certain areas are classified as restriction zones, in which only buses and trains are permitted. Basically, a few streets will be limited to public transportation.	There are a few hours that diesel-engine vehicles, such as heavy-duty vehicles, are not permitted.	Remains at the present state, 0; Two heavy traffic streets for implementation; Four heavy traffic streets for implementation Six heavy traffic streets for implementation;	Certain streets or areas will be restricted to only public transportation according to the volume of traffic per area to reduce the number of private cars that induce congestion and carbon emission.
Carpooling Approach Campaigns	Encourage ride-sharing to minimise the number of vehicles on the road while socialising	Less participation in the carpooling approach.	Remains at the present state, 30% of effort; Additional increment of 50% of participation effort; Additional increment of 70% of participation effort;	Increased participation per household in non-work and educational trips decreases driving alone tendency, as well as fuel consumption and living costs.
Indoor Planting Programmes	Encourage residents to plant trees around their houses to reduce their exposure to health impacts of air pollution.	Moderate efforts are being made to encourage resident participation.	Remains at the present state, 50% of effort; Additional increment of 70% of participation effort; Additional increment of 90% of participation effort.	Various functions of indoor planting decreases carbon emissions and balance the environment. Carbon tax funds can increase participation among residents.
Introduction of Electric Buses	Electric buses will replace diesel buses to reduce harmful pollutants.	No implementati on At the first stage level, implementation is on choice travellers who use transportation for purposes other than work or education	No implementation Improve from the current state to two electric buses; Improve from the current state to four electric buses; Improve from current state to 6 electric buses.	The implementation should be intensified in order to reduce the number of diesel buses. Electric buses with a short travel time but a high capacity will help to minimise air pollution in cities.

literature, the FGD, and the pilot study, pricing ranges of RM10, RM15, RM20, RM25, and RM30 were suggested.

Choice Set Designs

A decent and appropriate choice set design necessitates a thorough comprehension of the selection as well as a thorough evaluation. A full factorial design yielded 864 alternative choice sets for two-four, two-three, and one-six levels of air quality improvement attributes. Many items were impractical to include in the questionnaire, according to Kamri (2014). As a result, only a subset of available options (fractional factorial design) was considered. In this study, the Ngene 1.1.2 software was used to randomly computerise the choice sets.

12 scenarios were designed and randomly divided into two blocks of questionnaires (Block A: Questionnaire Set A and Block B: Questionnaire Set B), each with six scenarios (choice set). To make it easier for the respondents, the attributes and levels in the choice sets were substituted with wordings and pictures. Below is an example of a choice set (Figure 3).

Survey and Questionnaire

Face-to-face surveys were conducted in this study to ensure that all questions were accurately interpreted and answered rationally (Chin *et al.*, 2019). There were two sets of questionnaires (Set A and Set B), and the preference cards in each set were different. In that sense, each questionnaire collection was divided into four parts, as shown in Figure 4.

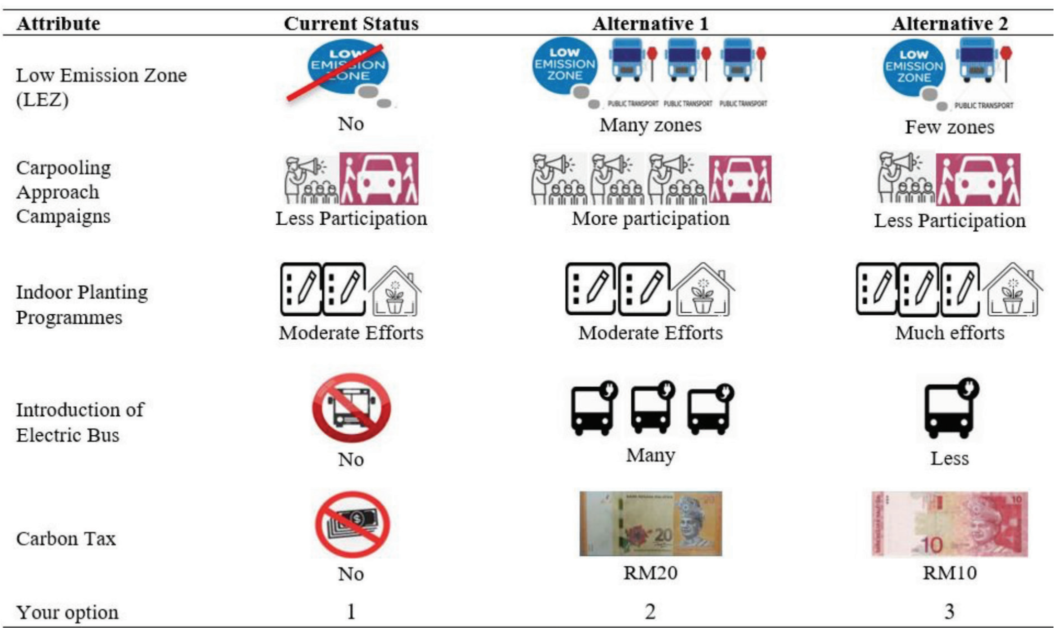

Figure 3: Sample of a final choice question (Scenario 1)

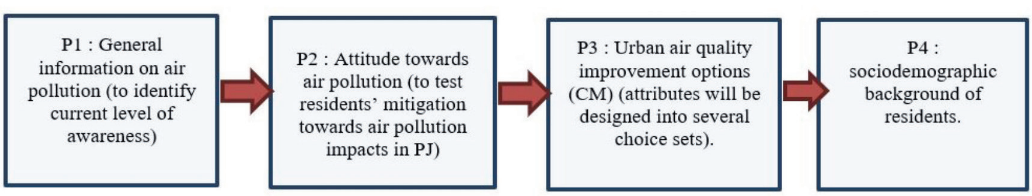

Figure 4: Questionnaire development framework

The first part of the questionnaire asked general questions about air pollution in PJ to measure the respondents' current awareness level. The following part employed a 5-point rating scale to measure the respondents' attitudes towards air pollution in PJ. Meanwhile, the third part of the questionnaire highlighted urban air quality improvement options in choice set design and split into two questionnaire blocks containing a detailed air pollution impact scenario for PJ. The final part was related to respondents' socio-demographic background.

Reliability and Validity

Three experts, primarily academics from Universiti Putra Malaysia validated this research, and provided their expertise on socioeconomic surveys in terms of comprehension, wording, sequence clarity, and timing. The validation was then reviewed and approved by Universiti Putra Malaysia's Ethics Committee for Human Subjects Research (JKEUPM).

A pilot study was conducted with 30 respondents (10% of the actual surveyed population) in four different areas: Seksyen, SS, PJU, and PJS, to assess the reliability of primary data. The reliability of this questionnaire was demonstrated by a value of 0.71 (using Cronbach's alpha) for questions on attitude toward air pollution (part 2 of the questionnaire). This finding was consistent with the findings of Chin *et al.* (2019), who reported that a good alpha value in social sciences varies from 0.7 to 0.9. Furthermore, the real survey was carried out with some suggested amendments based on feedback. The amendments were made to demonstrate the public's acceptance of attributes and levels and to provide a better understanding.

Sampling and Data Collection

As the cluster must represent the entire population of Petaling Jaya District, households were chosen based on geographical distribution as the sampling population for this research (Bazrbachi *et al.*, 2017).

The sampling was done in two stages: the first stage (selection of areas under four different clusters) and the second stage (selection of areas under four different clusters) (selection of streets based on the type of houses). Stratified random sampling was employed in the first stage. The number of respondents for each area was determined using 300 respondents (estimated sample size population) (by multiplying the proportion of households in each area by the estimated sample size), as shown in Table 3.

Systematic random sampling was used at the second stage to select respondents from each stratum (Ogiri *et al.*, 2019). Every fifth house in house blocks was chosen until the desired sample size was achieved. If the respondent from the fifth house was not accessible, the adjacent house will be selected.

Based on approximately 194,205 households in 2019, the survey sample size was determined to be 384, with a 95% confidence level and a 5% error margin. The target respondents were calculated based on sample respondents using the Christensen and Johnson (2014) sampling formula (Table 4). However, limited resources and the Official Movement

Table 3: The number of respondents for each area based on the estimated sample size population in Petaling Jaya (PJ)

Zone	Population	Number of Respondents
Seksyen	26754	42
SS,	33217	51
PJU	100515	155
PJS	33719	52
Total	194,205	300

Source: Petaling Jaya City Plan (2019)

Table 4: Sample sizes for various population size (10-50 million)

N	n	N	n	N	n	N	n	N	n
10	10	130	97	250	152	950	274	10,000	370
20	19	140	103	260	155	1,000	278	20,000	377
30	28	150	108	270	159	1,100	285	30,000	379
40	36	160	113	280	162	1,200	291	40,000	380
50	44	170	118	290	165	1,300	297	50,000	381
60	52	180	123	300	169	1,400	302	75,000	382
70	59	190	127	400	196	1,500	306	100,000	384
80	66	200	132	500	217	2,000	322	250,000	384

Source: Christensen and Johnson (2014)

Control Order (COVID-19 pandemic) restricted the face-to-face survey, with only final 300 respondents were willing to participate in the survey while the response rate was 90% where 30 respondents were unwilling to participate. Respondents were expected to be the head of a family have a valid driver's license.

Data and Econometric Model

The respondents' socio-demographic background and their attitudes toward air pollution in PJ, were evaluated using descriptive analysis by means of the SPSS Version 25. The multinomial logit model (MNL) regression and random parameter logit model (RPL) regression were used in the choice analysis. Equation 6 represents the basic equation for the choice modelling method, and Equation 7 represents the variables used in the MNL and RPL regression, as justified by Matthew *et al.* (2018), and they are as shown below:

$$\text{Utility} = \text{CAM} + \text{IND} + \text{LEZ} + \text{ELEC} + \text{COST}\ldots \quad (6)$$

Basic models include the addition of attributes; CAM (campaign participation), IND (programme participation), LEZ (low emission zone), ELEC (electric buses) and COST.

$$\text{Utility} = \text{CAM2} + \text{CAM3} + \text{IND2} + \text{IND3} + \text{LEZ3} + \text{LEZ4} + \text{ELEC2} + \text{ELEC3} + \text{ELEC4} + \text{COST} \quad (7)$$

Where CAM2 = Additional increment of up to 50% effort for campaign participation, CAM3 = Additional increment of up to 70% effort for campaign participation, IND2 = Additional increment of up to 70% effort for programme participation, IND3 = Additional increment of up to 90% effort for programme participation, LEZ3 = four heavy traffic streets for low emission zone implementation, LEZ4 = six heavy traffic streets for low emission zone implementation, ELEC2 = improvement of up to two electric buses, ELEC3 = improvement of up to four electric buses, and ELEC4 = improvement of up to six electric buses.

The marginal willingness to pay (MWTP) was measured using (Equation 8):

$$\text{MWTP} = \text{(coefficient of attribute)/coefficient of cost attribute} \quad (8)$$

Results and Discussion

Socio-demographic Background and General Information on Air Pollution

The respondents' demographic background is summarised in Table 5. In terms of gender, males (50.3%) outnumber females (49.7%). This distinction was attributed to limitation criteria for households chosen, in which only the heads of the family from each household were surveyed. The majority of respondents in PJ were between the ages of 21 and 30 (31.7%), employed in the non-environmental private sector (40.7%) and tended to stay in PJ for only three or four years (46.0%). Tao *et al.* (2019) revealed that the change of household members, home location or job promotes a change in car ownership, which leads to the change in mobility needs under relatively rare conditions, as significantly proved in this study. Regardless of whether they worked in the environmental or non-environmental employment sectors, most studies indicated that young adults (18-35 years old) were more concerned and mindful of environmental impacts (Chin *et al.*, 2019).

Furthermore, 60% of the respondents earn a monthly household income of ≤ Malaysian ringgit 5000 per month, and 35.7% of *Seksyen* households are classified as the mid-range income group (M_{40}) (Department of Statistics Malaysia, 2019). The results showed that most respondents (34%) earning between RM2501 and RM5000 are highly educated and more likely to work in the non-environmental private sector. This result is consistent with previous findings that the highly educated people in the middle-class group income are more aware and concerned about air pollution issues (Kaffashi *et al.*, 2016). However, high cost of living and estimated daily expenses that exceed the average income have forced many of them to migrate in search of employment. This argument was correlated with the employment status, with 80.7% employed and 19.3% unemployed.

Respondents from SS had a higher education level (62.7%) and were more likely to have private cars per household (96.1%) than the other respondents. This figure was anticipated due to the strategic location of SS as an inner-suburban area and a business hub (Department of Statistics Malaysia, 2019). Surprisingly, the results also reported a vast number of car users (91.3%): 38 in Seksyen, 49 in SS, 139 in PJU and 48 in PJS, indicating that every house had at least one car rather than a motorcycle or van. Abdul Halim *et al.* (2018) reported that the increase in motor vehicles on the road was due to Malaysia's urbanised areas, such as PJ.

The high dependency on private cars is related to the increase in the demand for services, but it has resulted in increased congestion, especially during peak hours (Bazrbachi *et al.*, 2017; Kaffashi *et al.*, 2016). As PJ acts as a central point for all car users in the Klang Valley, determining the number of private vehicle owners by city is challenging. In addition, PJ is connected to several neighbouring cities through highways known as traffic hotspots (Ministry of Transport, 2019). Due to a high number of residents recorded in the area, PJU had the highest representative sample proportion of respondents as compared with the other areas in PJ. This is due to the fact that PJU is an amenity centre and is linked with the NKVE highway (the main highway that connects the rest of the highways in the Klang Valley) (Petaling Jaya City Council, 2019). These results will justify the increase in congestion in PJ.

56.3% of respondents reported experiencing eye, nose, or throat discomfort. This statistic is comparable to the 51.3% that indicated that air quality had deteriorated (shown in Table 6). This finding indicates that irritation is more severe in Seksyen than in other regions, despite the fact that they have lower car ownership rates than SS. Additionally, the high carbon emissions associated with car users in PJ reported by Mohamad *et al.* (2018) corroborated this finding. Carbon emissions irritate various parts of the body based on the concentration, experienced by more than half of the respondents (De Pretto *et al.*, 2015). This finding was compatible with Chin *et al.* (2019), who found that only a fraction of people reduced driving activity to tackle urban air emissions, despite the fact that they were mindful that vehicle pollution was harmful to their wellbeing.

In contrast to other areas of Petaling Jaya, 52.9% of PJU respondents favour busses over trains, 32.9% travel occasionally, and 20.0% travel frequently. SS respondents are the most likely to drive a vehicle (96.1%), and they use public transportation the least (43.1%). This was emphasised by Ghadimzadeh *et al.* (2015), who claimed that ineffective public

Table 5: Demographic statistics from four different areas in Petaling Jaya

Items	**Seksyen N=42/(14.0%)**	**SS N=51/(17.0%)**	**PJU N=155/(51.7%)**	**PJS N=52/(17.3%)**	**PJ N=300/(100%)**
Demographic profile	N / (%)	N / (%)	N / (%)	N / (%)	N / (%)
Gender					
Male	21 / (50.0)%	28 / (54.9%)	76 / (49.4%)	26 / (50.0%)	151 / (50.3)
Female	21 / (50.0)%	23 / (45.1%)	79 / (51.0 %)	26 / (50.0%)	149 / (49.7)
Age					
21-30 years old	11 / (26.2%)	14 / (27.5%)	51 / (32.9%)	19 / (36.5%)	95 / (31.7%)
31-40 years old	12 / (28.6%)	12 / (23.5%)	26 / (16.8%)	9 / (17.3%)	59 / (19.7%)
41-50 years old	8 / (19.0%)	10 / (19.6%)	31 / (20.0%)	14 / (26.9%)	63 / (21.0%)
51-60 years old	6 / (14.3%)	13 / (25.5%)	26 / (16.8%)	8 / (15.4%)	53 / (17.7%)
> 60 years old	5 / (11.9%)	2 / (3.9%)	21 / (13.5%)	2 / (3.8%)	30 / (10.0%)
Education					
Primary	1 / (2.4%)	1 / (2.0%)	2 / (1.3%)	0 / (0%)	4 / (1.3%)
Secondary	20 / (47.6%)	18 / (35.3%)	65 / (41.9%)	20 / (38.5%)	123 / (41.0%)
Tertiary & Postgraduate	21 / (50.0%)	32 / (62.7%)	88 / (56.8%)	32 / (61.5%)	173 / (57.7%)
Stay					
≤ 2 years	17 / (40.5%)	22 / (43.1%)	65 / (41.9%)	20 / (38.5%)	124 / (41.3%)
3-4 years	19 / (45.2%)	24 / (47.1%)	70 / (45.2%)	25 / (48.1%)	138 (46.0%)
5-6 years	5 / (11.9%)	4 / (7.8%)	19 / (12.3%)	7 / (13.5%)	35 (11.7%)
> 6 years	1 / (2.4%)	1 / (2.0%)	1 / (0.6%)	0 / (0%)	3 (1.0%)
Household Income					
< RM2500	11 / (26.2%)	13 / (25.5%)	37 / (23.9%)	17 / (32.7%)	78 / (26.0%)
RM2501-5000	15 / (35.7%)	17 (33.3%)	52 / (33.5%)	18 / (34.6%)	102 / (34.0%)
RM5001-7500	9 / (21.4%)	11 / (21.6%)	32 / (20.6%)	8 / (15.4%)	60 / (20.0%)
RM7501-10,000	7 / (16.7%)	10 / (19.6%)	27 / (17.4%)	9 / (17.3%)	53 / (17.7%)
> RM10,000	0 / (0%)	0 / (0%)	7 / (4.5%)	0 / (0%)	7 / (2.3%)
Vehicles per household					
Motor					
Car	25 / (59.5%)	36 / (70.6%)	114 / (73.5%)	39 / (75.0%)	214 / (71.3%)
Van	38 / (90.5%)	49 / (96.1%)	139 / (89.7%)	48 / (92.3%)	274 / (91.3%)
	2 / (4.8%)	3 / (5.9%)	7 / (4.5%)	3 / (5.8%)	15 / (5.0%)
Job					
Employed	38 / (90.5%)	43 / (84.3%)	118 / (76.1%)	43 / (82.7%)	242 / (80.7%)
Unemployed	4 / (9.5%)	8 / (15.7%)	37 / (23.9%)	9 / (17.3%)	58 / (19.3%)
Sector					
Retired/Housewife/ Student	5 / (11.9%)	6 / (11.8%)	37 / (23.9%)	9 / (17.3%)	57 / (19.0%)
Non-environmental government sector	4 / (9.5%)	6 / (11.8%)	19 / (12.3%)	3 / (5.8%)	32 / (10.7%)
Non-environmental private industry	20 / (47.6%)	22 / (43.1%)	57 / (36.8%)	23 / (44.2%)	122 / (40.7%)
Government environmental sector	5 / (11.9%)	10 / (19.6%)	17 / (11.0%)	7 / (13.5%)	39 / (13.0%)
Private environmental sector	8 / (19.0%)	7 / (13.7%)	25 / (16.1%)	10 / (19.2%)	50 / (16.7%)

Table 6: General information on air pollution of Petaling Jaya

Items	Seksyen N=42/(14.0%)	SS N=51/(17.0%)	PJU N=155/(51.7%)	PJS N=52/(17.3%)	PJ N=300/(100%)
	N / (%)	N / (%)	N / (%)	N / (%)	N / (%)
Concern on Level of Air Pollution					
Gov and Env	17 / (40.5%)	12 / (23.5%)	49 / (31.6%)	17 / (32.7%)	95 / (31.7%))
Organisations Citizens only	0 / (0%)	0 / (0%)	0 / (0%)	1 / (1.9%)	1 / (0.3%)
Both	25 / (59.5%)	39 / (76.5%)	106 / (68.4%)	34 / (65.4%)	204 / (68.0%)
Rate of Air Pollution					
Much better	1 / (2.4%)	0 / (0%)	0 / (0%)	1 / (1.9%)	2 / (0.7%)
A little better	0 / (0%)	1 / (2.0%)	1 / (0.6%)	2 / (3.8%)	4 / (1.3%)
A little worse	19 / (45.2%)	28 / (54.9%)	82 / (52.9%)	25 / (48.1%)	154 / (51.3%)
Much worse	22 / (52.4%)	22 / (43.1%)	72 / (46.5%)	24 / (46.2%)	140 / (46.7%)
Health Condition					
Having more difficulty in breathing	9 / (21.4%)	8 / (15.7%)	44 / (28.4%)	8 / (15.4%)	69 / (23.0%)
Irritation to eyes/nose/throat	27 / (64.3%)	29 / (6.9%)	86 / (55.5%)	27 / (51.9%)	169 / (56.3%)
Wanting to move to another less polluted place	9 / (21.4%)	14 / (27.5%)	23 / (14.8%)	11 / (21.2%)	57 / (19.0%)
Asthma incidences	9 / (21.4%)	9 / (17.6%)	25 / (16.1%)	11 / (21.2%)	54 / (18.0%)
Others	0 / (0%)	0 / (0%)	11 / (7.1%)	0 / (0%)	11 / (3.7%)
Aware of API					
Yes	33 / (78.6%)	35 / (68.6%)	125 / (80.6%)	40 / (76.9%)	233 / (77.7%)
No	9 / (21.4%)	16 / (31.4%)	30 / (19.4%)	12 / (23.1%)	67 / (22.3%)
Practice API					
Yes	4 / (9.5%)	4 / (7.8%)	13 / (8.4%)	1 / (1.9%)	22 / (7.3%)
No	38 / (90.5%)	47 / (92.2%)	142 / (91.6%)	51 / (98.1%)	278 / (92.7%)
PT					
Yes	21 / (50.0%)	22 / (43.1%)	82 / (52.9%)	28 / (53.8%)	153 / (51.0%)
No	21 / (50.0%)	29 / (56.9%)	73 / (47.1%)	24 / (46.2%)	147 / (49.0%)
Mode of PT (BUS)					
No	22 / (52.4%)	31 / (60.8%)	73 / (47.1%)	26 / (50.0%)	152 / (50.7%)
Sometimes	7 / (16.7%)	10 / (19.6%)	51 / (32.9%)	15 / (28.8%)	83 / (27.7%)
Frequent	13 / (31.0%)	10 / (19.6%)	31 / (20.0%)	11 / (21.2%)	65 / (6.9%)
Mode of PT (TRAIN)					
No	21 / (50.0%)	32 / (62.7%)	75 / (48.4%)	27 / (51.9%)	155 / (51.7%)
Sometimes	8 / (19.0%)	8 / (15.7%)	44 / (28.4%)	12 / (23.1%)	72 / (24.0%)
Frequent	13 / (31.0%)	11 / (21.6%)	36 / (23.2%)	13 / (25.0%)	73 / (24.3%)

Note: PT - Public Transport; Gov - Government; Env - Environment & API - Air Pollution Index transit services encourage citizens to opt for private transport. This is especially relevant as a car becomes a necessity (Tao *et al.*, 2019) thereby potentially biasing people away from using more environmentally friendly transport modes such as public transport. Although a considerable body of research has shed light on the attitudinal dimensions of car ownership and usage, few have investigated the potential influence of car ownership on attitudes towards alternative transport modes from an international comparative perspective. Across cities with distinct mobility cultures and economic backgrounds, car ownership may have differentiated influences on how people view various transport modes, yet little research exists in this area. This study aims to bridge this knowledge gap by investigating the relationship between car ownership and attitudes towards public transport in two vastly different metropolises, Guangzhou, China and Brisbane, Australia, while taking account of environmental concerns, past behaviour and socio-demographic characteristics. Drawing on two survey data sets, we derived measurements that directly compare the perceived difference between bus transit and cars, and constructed latent attitudinal variables based on loose-matching and strict-matching criteria to enable a more robust test of hypotheses. Using structural equation modelling (SEM. Car commuters will have a negative perception of the accessibility and efficiency of local public transportation (Bazrbachi *et al.*, 2017). As PJU is a hub of amenities and is connected to the NKVE highway (the key highway that links the majority of the Klang Valley's highways), as stated by the Ministry of Transport (2019), residents are recommended to commute by trains or buses to prevent congestion. 53.2% of respondents indicated that they favoured the PJ city buses. These new findings emphasise the critical need to improve public transportation in order to tackle urban air quality in PJ.

The findings indicated that although roughly 77.7% of respondents were conscious of the Malaysian Air Pollution Index, merely 7.3% monitor it prior to engaging in outdoor activities. The majority of PJ respondents (77.7%) were aware of the index, and they believed that the city's air quality had deteriorated somewhat over a five-year period. This finding contradicted the index, which indicated that PJ has a low level of air pollution (Mohamad *et al.*, 2018). Due to marginally low air quality, the study found that the health effects were not detrimental. Additionally, 68.0% of respondents believed that collaboration between the government, environmental organisations, and residents will significantly increase air quality in PJ before the risk to human health and the atmosphere became unmanageable. Zahedi *et al.* (2019) confirmed that successful corrective policies were feasible because residents were mindful of the effects of air emissions.

Residents' Attitude towards Air Pollution

Table 7 summarises respondents' attitudes about enhancing air quality in PJ. The overall average mean score on the 5-point Likert scale was 3.88, showing a strong degree of concern among respondents about the current state of air quality in PJ.

Item 6 has the highest mean score demonstrating the PJ respondents' willingness to change. Implementing low-emission vehicles requires enacting policies aimed at reducing air pollution (Lee *et al.*, 2019), especially carbon emissions, which are high in PJ. Schmitz *et al.* (2018) cited a policy in Potdam, Germany, that prohibited diesel vehicles that did not meet emissions standards from entering cities in order to improve air quality.

The overwhelming majority of respondents strongly agree (59.3%) on item 1 and partially agree (28.7%) on item 5, which requires coordination and commitment from all stakeholders to increase a city's or country's air quality. Government initiatives aimed at reducing air emissions have struggled to garner public support because they neglected to determine the public's perception of specific policies (Fontes *et al.*, 2018). Similarly, new policy Robertson (2017) on toll rates for private and public transportation has met with

Table 7: The residents' attitudes towards air quality in Petaling Jaya

Items	Frequency (%)					Mean	Level
	1	2	3	4	5		
We are all equally responsible for the degradation of air quality.	2 (0.7)	30 (10.0)	51 (17.0)	39 (13.0)	178 (59.3)	4.20	**3**
It is useful to estimate the monetary value of the services that the ecosystem provides us.	0 (0)	19 (6.3)	151 (50.3)	116 (38.7)	14 (4.7)	3.42	**2**
People who pollute our air should pay for damage done to the environment.	54 (18.0)	51 (17.0)	24 (8.0)	78 (26.0)	93 (31.0)	3.35	**2**
Air quality improvement is currently more important than the economic growth of Malaysia.	3 (1.0)	6 (2.0)	44 (14.7)	83 (27.7)	164 (54.7)	4.33	**3**
It is useful to do what I can to improve air quality unless everyone does the same.	57 (19.0)	86 (28.7)	38 (12.7)	86 (28.7)	33 (11.0)	2.84	**2**
Use of low emission fuel vehicles should be encouraged by governments.	0 (0)	0 (0)	10 (3.3)	97 (32.3)	193 (64.3)	4.61	**3**
I am willing to accept cuts in my standards of living in order to protect the environment.	1 (0.3)	18 (6.0)	138 (46.0)	125 (41.7)	18 (6.0)	3.47	**2**
Governments should adopt Sustainable Development as a national priority to improve air quality.	0 (0)	2 (0.7)	10 (3.3)	99 (33.0)	189 (63.0)	4.58	**3**
I would contribute part of my income if I were sure that the money would be used to prevent air pollution.	3 (1.0)	14 (4.7)	118 (39.3)	150 (50.0)	15 (5.0)	3.53	**2**
I worry too much about industrial development polluting the atmosphere and degrading humans' health.	0 (0)	0 (0)	11 (4.7)	136 (45.3)	153 (51.0)	4.47	**3**
Average Mean						3.88	**3**

Note: The measurement scale ranged from Strongly Disagree to Strongly Agree. For Five-Point Likert Scale: using the formula: (Highest value - lowest)/ No of categories in statistics calculation: levels = (5-1)/3: 1.333 hence the first level: low (1) shall start from (1+1.333) 1+2.339; Medium (2): 2.34-3.669; High (3): 3.67-5.0

widespread resistance from residents. However, no discernible declines in the usage of private vehicles have occurred.

For items 2 and 3, which were closely related, a medium score of (2) was obtained. Majority of respondents gave a neutral rating to items 2 and 7, while agreeing on item 9. This reflected respondents' lack of concern and environmental knowledge (Akhtar *et al.*, 2017), although the majority of respondents had a high level of education (Table 6), especially in terms of understanding the economic benefit of reducing air pollution in PJ. Kaffashi *et al.* (2016) argued that a polluter-pays principle (in a microeconomic viewpoint) was essential to internalise external costs; in this case, private car drivers should be forced to compensate because they inevitably contribute to air emissions in PJ. Surprisingly, items 7 and 9 both had a mean score of 3.47 and 3.53. Even though respondents indicated that PJ had relatively high living costs, they indicated a willingness to devote a particular%age of income to minimise air emissions, demonstrating their genuine awareness of life quality being reduced as a consequence of pollution.

High mean scores (3) were obtained for items 4, 8, and 10, in which the majority of respondents strongly agreed (54.7%, 64.0%, and 51.0%, respectively). PJ is the commercial hub of the Klang Valley and the engine of Selangor's economic growth; the City Council (2019) reported that economic growth is the most critical factor in PJ's development. However, the findings for items 4 and 8 indicate that citizens are more concerned with enhancing air quality than economic development, owing to the risks to human health and the environment. Malaysia is currently on track to achieve sustainable development by 2030, and respondents strongly agreed that the government should make sustainability a national priority, especially in order to improve air quality.

Discrete Choice Experiment

Table 8 summarises the choice results. When contrasting the two models, the MNL model's log likelihood function value (-1665) was smaller than that of the RPL model (-1652). Previous research established the superiority of the RPL model by demonstrating that it has a lower functional value than the MNL model (Kaffashi *et al.*, 2016). Similarly, the RPL model exhibits a pseudo-R2 value of 0.164 (16.4%) in this study, which is slightly higher than the MNL model's value of 0.121 (12.1%). According to Matthew *et al.* (2018), the pseudo-R2 value for the RPL model in this study is between 0.1 and 0.4, suggesting a good fit range for the RPL model. As a result, attributes and levels mentioned under the RPL model obtained a better rate of choice than those listed under the MNL model in this study.

The marginal value findings indicate that a higher cost implies a higher utility, vice versa, as demonstrated by Matthew *et al.* (2018). Following that, in terms of the attribute findings, a negative coefficient revealed that the cost attribute (bid price) was compatible with demand theory. As a result, the higher the bid price produces the lower the acceptance, and vice versa.

The analysis of the CAM attribute revealed that respondents were willing to increase their commitment by 70% to engage in carpooling initiatives (CAM3). These results are compatible with Vanderschuren and Baufeldt (2018), who advocated for a reduction in solo driving, reduced fuel consumption, and reduced living expenses by encouraging only choice travellers (those travel other than working and educational trip purposes). This finding is indicative of respondents' concern to reduce their reliance on private transport and pollution at peak hours in PJ. Additionally, respondents favoured a 70% increase in effort for participation (IND2) in indoor planting programmes to reduce their susceptibility to health effects induced by air emissions.

Subsequently, respondents preferred that some streets (LEZ3) be reserved for low emission vehicles. Apart from establishing emission standards, regulations could be imposed during peak hours to allow only public transportation,

Table 8: Choice experiment results of two different models

VARIABLE	MNL				RPL			
	Coefficient	**Standard Error**	**P[|Z|>z**	**Marginal value (RM)**	**Coefficient**	**Standard Error**	**P[|Z|>z**	**Marginal value (RM)**
COST	- 0.15094	0.01269	0.000***	-	- 0.25870	0.07504	0.000***	-
CAM 2	0.18263	0.18051	0.312	1.21	0.20570	0.31518	0.514	
CAM 3	0.71441	0.08290	0.000***	4.73	0.96908	0.29391	0.001***	3.75
IND 2	0.31883	0.17966	0.076*	2.11	1.38436	0.50183	0.006***	5.35
IND 3	0.25372	0.10434	0.015**	1.68	0.42802	0.21469	0.046**	1.65
LEZ 3	0.93149	0.14539	0.000***	6.17	1.76061	0.54187	0.001***	6.81
LEZ 4	0.45633	0.12343	0.000***	3.02	0.65951	0.21726	0.002***	2.55
ELEC 2	2.08427	0.14503	0.000***	13.81	3.33950	1.04514	0.001***	12.91
ELEC 3	2.31283	0.22670	0.000***	15.32	3.75221	1.09822	0.001***	14.50
ELEC 4	2.62025	0.25413	0.000***	17.36	4.42389	1.48313	0.003***	17.10
Number of Observations	5400				5400			
Log likehood function	-1665				-1652			
Pseudo-R^2	0.121				0.164			
X^2					650			
Prob [X^2]					0.000***			

***, **and * = significant at 1, 5 and 10% levels respectively taxis, and ride-sharing cars (Lee *et al.*, 2019). This solution is preferred by respondents who wish to see PJ transition to zero-emission cars in order to minimise air emissions (Table 7). Additionally, respondents preferred electric buses to diesel electric buses, which produce toxic emissions, and they preferred ELEC4 over ELEC2 and ELEC3. Schmitz *et al.* (2018) published similar results.

Marginal Willingness to Pay Estimation

Evaluating consumer welfare was essential in determining an appropriate and acceptable carbon tax. Consumer welfare was quantified in this analysis using marginal willingness to pay for nine key interaction variables, more specifically the RPL model as justified by Matthew *et al.* (2018). Hence, CAM3 + IND2 + LEZ3 + ELEC4 = (RM3.75 + RM5.35 + RM6.81 + RM17.10) = RM33.01.

If the carbon tax was approximately RM33 per month (RM 1.10 per day and RM396 per year), the estimated revenue is RM76,905,180 per year (194,205 households, as per Petaling Jaya City Council (2020), multiplied by RM396). Hence, the government will receive RM6, 408,765 per month. This amount will then be used as conservation value of air quality improvement for the PJ residents. The tenth Malaysian Plan emphasises on reducing private vehicle ownership and increasing Malaysians' reliance on public transportation. In order to reduce the carbon emissions, mainly from the private vehicles in the Klang Valley, Malaysia, Kaffashi *et al.* (2016) proposed a 30% increment in toll fare, an increase of RM5 in parking fees and a RM2.50 increase in congestion fees. The present study highlighted the implementation of carbon tax on Petaling Jaya residents. Although it is new in Malaysia, it has been found to be an efficient approach in other countries. As compared to the previous study, RM33 per month (RM1.10 per day) is a reasonable and appropriate expense that should be taken into consideration when it comes to reducing carbon emissions in PJ.

Conclusion

In Malaysia, air quality management is governed by a variety of policies and laws, including the Environmental Quality Act (1974), subsidiary legislation such as the Malaysian Ambient Air Quality Standard 2013, the Environmental Quality (Clean Air) Regulations 2014, and a few guidelines such as the Air Pollution Index (API), the Haze Action Plan, and The Nation (Department of Environment Malaysia, 2019). Despite legislative frameworks, and policies limit on vehicle exhaust emissions, improving fuel efficiency, reducing the usage of diesel fuel, and encouraging non-motorized modes of transportation at the local level, all of which were implemented in order to decrease the rate of carbon pollution by 45% by 2030 (Ministry of Transport, 2019). In line with the 2030 Agenda for Sustainable Development, the Selangor State Structural Plan highlighted Sustainable Development Goal 11 on developing sustainable cities and communities, which encourages the use of sustainable transportation systems by increasing public transportation use in order to mitigate urban cities' negative environmental impacts, in which the present study concentrated on.

Furthermore, this study ascertained residents' attitudes toward air pollution, their preferences for urban air quality improvement options through choice modelling, and the importance of urban air quality improvement attributes in PJ. To begin, the current study sought to determine residents' attitudes toward air pollution in Petaling Jaya. The findings indicated that the highly educated and those with high living expenses depend heavily on private vehicles and seldom utilise public transportation. The overall high mean score indicated that residents have a positive attitude and were willing to contribute and collaborate with the government to improve PJ's air quality. Second, this research employed the choice modelling method to ascertain residents' preferences for improving urban air quality in Petaling Jaya. The marginal willingness to pay (MWTP) value for each variable showed the number of possible trade-offs between attribute improvement levels and their present state. The findings indicated that residents preferred a 70% increase in funding for carpooling campaigns and a 70% increase in funding for indoor planting programmes. Additionally, they advocated for the conversion of four major congested streets to low-emission zones and the introduction of six electric buses. These preferences demonstrate their willingness to contribute to PJ's carbon reduction efforts. Selangor's Road Transport Department may propose a 'conservation fee' from toll or congestion charges. For instance, they may maintain the current toll charges or the forthcoming congestion fee of RM84 each month in PJ, and the difference between the MWTP and the conservation fee, i.e., RM33 each month, could be obtained from each driving individual.

Concerning the carbon tax aimed at reducing the amount of carbon content in the atmosphere, PJ residents widely accepted a conservation fee. Most crucially, emerging economy, such as Malaysia's, is anticipated to meet the climate mitigation goals when carbon taxes on electricity, transport, oil and gas sectors are implemented, accounting for approximately 70% of the annual national emissions (Joshi, 2019). Although the carbon taxes are not widespread in Asia, the Malaysian government is committed to reducing the carbon emissions by 45% by 2030 in accordance with the 2016 Paris Agreement (MESTECC, 2019). Particularly, PJ was selected among 7,000 cities worldwide with climate change mitigation goal, in which the rise in carbon emissions from mobile sources was expected to be one of contributing factors to climate change (Mohamad *et al.,* 2018). The remarkable reduction of carbon emissions necessitates an implementation of carbon taxes in Malaysia, commencing with an urbanised city. After demonstrating the efficacy of implementation, a mandatory approach can be inferred. Therefore, the present study will serve as a baseline for the implementation of mandatory carbon taxes for Malaysian citizens.

Thus, the present study successfully identified novel attributes such as low emission zones, carpooling campaigns, indoor planting programmes, and the introduction of electric buses that had not been included in previous studies when determining the preference for urban air quality improvements and the introduction of carbon tax as a pricing medium by focus group discussions and a review of previous studies. Therefore, this study may prove to be beneficial for cities worldwide in terms of economic perspective to improve air quality. Additionally, some recommendations for further studies have been made. To begin, aside from the Choice Experiment used in this study, other techniques such as Choice Modelling, paired comparison, contingent rating, and contingent ranking may be tested. Second, as the study examined the MNL and RPL models, future research could examine the Latent Class Model (LCM) in greater detail. Additionally, a prospective study should consider the interaction of additional variables, such as physiographic variables. Apart from variables, it is inevitable that the implementation of movement restrictions in response to the COVID-19 pandemic would affect consumers' choice of public transportation, suggesting a greater preference for private automobiles, another concern that future studies could discuss.

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