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Willingness to Pay for Domestic Water Service Improvements in Selangor, Malaysia:

A Choice Modeling Approach

Mohd Rusli Yacob[1]

Alias Radam[2]

Zaiton Samdin[3]

Abstract: The tasks and responsibilities of domestic water service management in Malaysia are handled by various government agencies. Sufficient water service and resources management is required for sustainable water resources conservation. In order to realized water resource conservation, economic effectiveness of water utilization (consumers), maintenance of water quality supply (source of water supply) and efficiency in allocating water resources (agencies) needs to be addressed. The objective of the study is to assess community preferences and values relating to alternative water service management with particular concentration on water service improvement. This study has applied Choice Experiment (CE) to investigate the current policies and potential alternative of water service management in Selangor. The studies are based on 230 respondents in Subang Jaya that were randomly interviewed for data collection in October to December 2008. The findings indicates that respondents are willing to pay higher for drinking water as compared to the current rate with improved in water quality (WQ), reduced the frequency of water interruption (WI) and increases in the consumer trust to tap water (CT). The finding of this study is very important in order to assists and recommends the policy makers towards efficiency of domestic water service management in Malaysia.

Key words: Choice experiment; Water conservation; Consumer preference; Choice modelling; Willingness to pay

1. INTRODUCTION

The tasks and responsibilities of water resources management in Malaysia, includes the state of Selangor are handled by various government agencies. In the case of domestic water supply management in Selangor,

[1] Corresponding author. Department of Hospitality and Recreation, University Putra Malaysia, 43400 UPM Serdang, Malaysia.
E-mail: mroy@econ.upm.edu.my; mroy28@gmail.com
[2] Department of Management and Marketing, University Putra Malaysia, 43400 UPM Serdang, Malaysia.
E-mail: alias@econ.upm.edu.my
[3] Institute of Tropical Forestry and Forest Products, University Putra Malaysia, 43400 UPM Serdang, Malaysia.
E-mail: zaisa@econ.upm.edu.my
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it managed by Syarikat Bekalan Air Selangor (SYABAS) a private company. The differences in governance could create conflict towards sustainable water resources management. Sufficient water resources management is required for sustainable water resources conservation. In order to realized water resource conservation, economic effectiveness of water utilization (consumers), maintenance of water quality supply (source of water supply) and efficiency in allocating water resources (agencies) needs to be addressed.

The public attitude plays an important role in order to ensure the sustainability of water supply and water use in our country. The public should be educated on the impacts of littering and rubbish disposal into the rivers. The main source of water supply in Malaysia comes from the rivers, where we have more than 150 river systems in the country (Chan, 2000a). However, these rivers are treated as raw sewers by the public as everything from domestic rubbish.

The public must be involved in water conservation initiative or water resources management. Participatory approach by identifying the public preferences as well as policy makers and stakeholders regarding water resources management options is one of the ways to involve the public and stakeholder towards conservation of water for future uses. The important solution here is to purpose alternative water resources management; either by enforcement of legislation to protect water catchments and rivers; by public awareness on water conservation; use pricing of water tariffs to control the abuse of water. The alternative water resources management is very important in order to ensure that water resources remain sustainable and our children and future generations are guaranteed with adequate and clean water.

The objective of this paper is the determination the household water service improvement through a willingness to pay of choice experiment approach. The empirical studies on assessment of water quality, water service improvement in Malaysia is still new compared to other studies in developing countries. Thus, this paper is structures as follows. Section 2 provides the application of choice experiment in measuring water service improvement. Section 3 develops the choice experimental approach for water services used in this study. Section 4 discusses the empirical findings and section 5 concludes the paper.

2. THE APPLICATION OF CHOICE EXPERIMENTS IN VALUING WATER SERVICE

There are many studies that have been used choice experimental approach to evaluate the consumer preferences of water services or household water demand. Hensher et al., (2005) used a choice experiment to value household water supply attributes in Canberra, Australia. The attributes used were related to service interruptions such as frequency, time of the day, duration, price etc. Their findings show that respondents were willing to pay more in order to reduce the number water interruptions. Another studies was conducted in Australia are those by MacDonald et al., (2005) assessed household willingness to pay to avoid outages (frequency, timing, duration) and information (notification and telephone response) of for water supply and disposal in Canberra Australia.

A similar studies were conducted Willis et al., (2005) used a state choice analysis to assess water company consumer preferences and willingness to pay for service improvements in the United Kingdom. Abau-Ali and Carlson (2004) used a similar approach to evaluate the welfare effects of improved health status through increased water quality in Cairo, Egypt. Hope (2006) also used a choice experiment in his studies to evaluate the water policy response from rural community in South Africa. Nakatani et al., (2007) applied a choice experiments in assessed the impact of water quality improvement on the different type of environmental issues in Soka City, Japan.

However, most of the studies are in developed countries. In developing countries, the used of choice experiment approach in valuing water service are very few except by Nam and Son (2005) who compared the choice experiment and contigent valuation methods for valuing domestic water quality and pressure in Ho Chi Min City in Vietnam. In Malaysia, to our knowledge only few applied a choice experiment in environmental economics valuation; Mohd Rusli et al., (2009) studies on visitor's preferences for ecotourism facilities and services in Redang Island Marine Parks and Othman et al., (2004) studies on environmental values and forest resource management options. However, both studies are not in water service assessment.

3. METHODOLOGICAL APPROACH

3.1 The Choice Experiments

In this study, the methodology used to estimate the value of water service improvement is Choice Experiments (CE). Choice Experiment was originally proposed by Louviere and Worthworth (1983) in order to avoid some of the problems and *ad hoc* assumptions associated with rank order or rating scale data. It involves the design of experiments in which choice situations described by a combination of attributes, referred to in the literature as choice or attribute profiles, are presented to individuals in a hypothetical market. Respondents are then asked to make choices between the different profiles which implicitly reveal their preferences. The choice responses are directly translated into marginal values through the estimation of a discrete choice model reflecting the trade-offs respondents make between the attributes in a manner consistent with random utility theory (Bateman *et al.,* 2002).

In the CE visitors are asked to choose a single preferred combination of attributes from the alternatives in the set provided. This approach has a format with combinations of attributes that make up specific situations selected from the universe of possible situations. The first study to apply choice experiments to non-market valuation was Adamowicz *et al.,* (1994). Since then there has been an increasing number of studies. In the CE format, the respondent is asked to choose between alternatives that are described by attributes. These combinations of attributes make up specific situations that are selected from a universe of possible situations. This is analogous to the problem of decision-making by visitors, who have to assess a variety of potential attributes in the alternatives before finally deciding to choose the best of the alternatives.

In the CE exercise, the first task involves identification of the attributes which are most important in the market investigated. The list of attributes needs to be carefully established, preferably using prior exploratory research backed by a mixture of experience and knowledge of the particular research problem. Once the attributes are identifed they are partitioned into generic groups with each group defined by elemental levels.

The CE approach allows trade-offs between goods in the choice set or attribute profile, as well as monetary compensation (Hanley et al., 2001). This implies that the environmental policy makers can examine the number of water service attributes that the visitors are willing to trade off for one another. In this study, for example, the SYABAS or decision makers can examine the numbers of water service attributes related to water quality that the household are willing to trade-off for improvement. This information could improve the efficiencing of water service management in Selangor.

Generally, in a CE study, the respondents will choose from among 'alternatives by decision makers'. In this case, respondents act as decision makers and are required to choose from among the alternatives or policy options. There are two aspects of CE related to theoretical foundations; theory of value by Lancaster (1966) and random utility theory by Manski (1977). Lancaster's theory specifies the value of a good as a function of the attributes that characterize the good rather that the good *per se*. This theory gives rise to the utility function that is used for the application of CE. Meanwhile, the random utility theory (RUT) helps to derive the best estimator of the unknown true utility function. This theory relates utility directly to the probability of choosing an alternative from a set of alternatives.

3.2 Conditional Logit Model of Water Service Improvements

Conditional logit is regularly used to estimate the choice modeling exercise. It is one of the simplest variants of discrete choice method. In this study let us say a respondent *n*, faces a choice among *J* alternatives in a choice set. Label the observed attributes, either in qualitative terms (e.g. very good, high, medium) or quantitative terms (e.g. 10%, 20%) of alternative *i* in the choice set as faced by the respondent, *n* as the vector X*in*. The probability (P_{in}) that respondent *n* chooses alternatives *i* depends on the observed attributes of alternative *i* compared with other alternatives (ie. X*in* relative to all X*jn*; j≠i). In this case, there are three alternatives; management option 1, management option 2 and the *status quo*. The probability can be represented by a parametric function of general form;

$$P_{in} = f(X_{in}, X_{jn}; j \neq i, \beta) \qquad \text{---------- (1)}$$

Where;

P_{in} = probability of respondent *n* choosing alternative *i*

X_{in} = a vector of observable characteristics of alternative *i* accessible to respondent *n*

X_{jn} = a vector of observable characteristics of alternatives *j* accessible to respondent *n*

In this case, *f* is the function that relates the observed data with the choice probabilities. This function is specified up to some vector of taste parameter β to be estimated.

Thus, in order to derive of discrete choice model or the specific function of *f* in Equation (1), let us consider the utility obtained by the respondent from each alternative. Take the vector of all attributes of alternative *i* as faced by respondent *n* as Z_{in}. According to Lancaster (1966), the utility that respondent *n* obtains from alternative *i*, denoted U_{in} can be written as follows;

$$U_{in} = U(Z_{in}) \quad \text{----------} \quad (2)$$

U is a function. The respondent chooses the alternative that provides the greatest utility. When the respondent *n* chooses alternative *i*, we can write the behaviour model if and only if $U_{in} > U_{jn}$, ; $j \neq i$. Then we can write; $U(Z_{in}) > U(Z_{jn})$; $j \neq i$. This utility represents the deterministic component since the respondent is already known on their utility. However, in the choice probability, the element of Z_{in} is divided into two components; systematic component (denote as V) and random component or error term (denoted as ε_{in})

$$U_{in} = V(X_{in}) + \varepsilon_{in} \quad \text{----------} \quad (3)$$

In this case, the ε_{in} is not known and is therefore treated as a random term. The joint probability density of the random vectors, $\varepsilon_n = (\varepsilon_{n1}, \varepsilon_{n2} \ldots \varepsilon_{nj})$ is denoted $f(\varepsilon_n)$. With this density, the researcher can make probabilistic statements about the decision-maker's choice. In random utility terms, the probability that respondent *n* chooses alternative *i* is (Train, 2003);

$$P_{in} = \text{Prob}(V_{in} + \varepsilon_{in}) > (V_{jn} + \varepsilon_{jn}) \; ; \; j \neq i$$

$$= \text{Prob}(V_{in} - V_{jn}) > (\varepsilon_{jn} - \varepsilon_{in}) \; ; \; j \neq I \text{ ----------} \quad (4)$$

The probability that an individual randomly drawn from the sample population of respondents will choose alternative i equals the probability of the difference between the systematic utility levels of alternative i and j for all alternatives in the choice set. This probability is a cumulative distribution, when the probability that each random term, $\varepsilon_{jn} - \varepsilon_{in}$ is lower than the observed quantity $V_{in} - V_{jn}$. Thus, by using the density $g(\varepsilon_n)$ this cumulative probability can be written as ;

$$P_{in} = \int I(\varepsilon_{jn} - \varepsilon_{in}) < (V_{in} - V_{jn})\, g(\varepsilon_n) d\, \varepsilon_n \quad \text{----------} \quad (5)$$

In order to estimate a random utility model, a distribution on error terms must be specified. In this case, in order to develop a conditional logit model, McFadden (1974) and Train (2003) were referred to. By assuming that all of the error terms in the choice set are independently and identically distributed, IID with a Weibull distribution[4], the conditional logit model can be developed. Thus, the probability of respondent *n* choosing alternative *i* can be formed as:

$$P_{in} = \frac{\exp(\mu V_{in})}{\sum_j^J \exp(\mu V_{jn})} \quad \text{----------} \quad (6)$$

By assuming that V_{in} is linear in parameters, the functional form of the respondent systematic component of the utility function can be expressed as:

$$V_{in} = \beta_1 X_{in} + \beta_2 X_{2in} + \ldots + \beta_k X_{kin} \quad \text{----------} \quad (7)$$

[4] Weibull distribution is also known as the Type I extreme value, Gumbel distribution, double exponential distribution and implies that the error terms are logistically distributed (Freeman, 1993)

Where Xs are variables in the utility function and the β_s are coefficients to be estimates. If a single vector of coefficients β that applies to all the utility functions associated with all the alternatives is defined and the scale parameter μ=1, thus the equation (7) can be rewritten as:

$$P_{in} = \frac{\exp(\beta' X_{in})}{\sum_j^J \exp(\beta' X_{jn})} \quad \text{----------(8)}$$

Where, P_{in} is a Respondent *n* choice probability of alternative i, X_{in} and X_{jn} are the vectors describing the attribute of *i* and *j* and β is a vectors of coefficients. Then, the next step is to estimate the choice probability and to calculate the welfare measure. The ratio of an attribute's coefficient and the price coefficient represents the marginal implicit price of the attributes. This ratio represents the implied change in the implicit price of the attributes relative to a current situation as in the equation below:

$$\boldsymbol{\rho}_{i,k} = \frac{\partial V / \partial X_{i,k}}{\partial V / \partial P_{i,k}} = -1 \frac{\beta_{i,k}}{\beta_{i,k=p}} \quad \text{----------(9)}$$

3.3 Data Collection

The first stage in the CE question design was to choose a set of characteristics or attributes related to the policy implemented, which was related to the study site problem. In this study, the water service values had a variety of attributes for consideration and most of the attributes were expressed in qualitative rather than quantitative terms. The first stage of attributes and levels selected were identified in this study by using relevant sources such as literature, government annual reports, brochures, and expertise judgments. During this process, the selection of the main attributes and levels was closely related to the current water service policies implemented in study area. All levels and attributes included the current management practices as the *status quo* is presented in Table 1.

Table 1: Attributes and Levels Used in the Study

Attribute	Description	Levels	A priory expectation
Water quality (WQ)	Quality of water supply is subject to the Water Quality Standard that corresponds with WHO specification; The standard range for WTO are (Acidity or pH; 5.5-8.5), AMN (10mh/l), Turbidity (40 NTU) and Hardness (500 mg/l)	Very Good *Good* Fair	Positive[5]
Water Interruption (WI)	Water interruption refers to the frequency and period of time when it happens: occurs few times a year, still occur at least once a year and it never happened in a year.	*Frequently* Sometimes Never	Positive
Consumer trust (CT)	Relates to the quality of water supplied to consumer at present. Level of trust are refers: Fulfill the drinking water quality standard and safe to be consumed directly from tap, after filtration or after filtration and boiled	High Moderate *Low*	Positive
Water price (WP)	A percentage of current water prices per household per meter[3]. The current price was RM0.56/cubic meter.	*No change* Increase 10% Increase 20% Increase 30%	Negative

Note: *Italics* present the status quo attribute levels

This study applied a series of multiple choices. The choice options or management options for water service attributes differed according to the choice sets. Each choice set had three alternatives or *management options*. Management options one and two are the alternatives; meanwhile, management option three is always the same as the 'current management practice'or *status quo* option. The *status quo* option was provided for respondents who do not want a change for the management options described.

[5] This implies that an increase in the attribute level would increase the probability of choosing the option.

In the CE questionnaire, the choice sets were the main portion and were designed to elicit the choice-based information. Generally, designing a choice experiment involves determining a set of decision attributes and levels to represent the variation in the real situation (Adamowicz *et al.,* 1994). Furthermore, it involves determining the choice sets or number of alternatives that respondents have in making a decision, and ensures that the task is not too long or too difficult or lacks sufficient realism and credibility. In addition, there are three ways of reducing task complexity if the cases have too many attributes; by reducing the number of alternatives or levels, grouping the attributes into subsets and splitting them into blocks Bateman *et al.,* (2002).

All CE studies require an experimental design. The design is formulated from number of attributes (or factors) or the number of levels for each attribute. In a fractional factorial design (FFD), only a subset of all possible combinations of attributes levels is selected. This design reduces the number of alternatives the respondent evaluates and still allows the estimation of the unknown parameters the researcher seeks. Therefore, in this study with a fractional factorial design (FFD) of $3^3 4^1$ for water service attributes, the total number for choice sets were 12 optional choices after two choices has been drawn due to implausible or dominated alternatives (Bennett, 1999).Thus, in this study, there are five choices in total. These options did not include alternatives for '*status quo'*. The example of a CE question is shown in Table 2.

If Management Option 1 and 2 below are the only alternative to the Water Supply Management, which one is your choice? (Please choose ONE and tick in the box provided)

Table 2: Example of Choice Experiment Question

	MANAGEMENT OPTION 1	**MANAGEMENT OPTION 2**	**CURRENT MANAGEMENT**
Water Quality	Very Good	Very Good	Good
Water Supply Interruption	Happens Sometimes	Happens Frequently	Happens Frequently
Consumers' Level of Trust	Low	Medium	Low
Water Price Level	Increase by 10%	Increase by 10%	Current Price
CHOICE			

A pilot survey was conducted before the actual survey, with the purpose of testing the questionnaire, including checking the choice of wording, the clarity of questions, and avoiding ambiguous questions. The data was collected during the period of Oct – Dec 2008. This study applied the personal interview data collection technique from house to house randomly chosen in Subang Jaya, one of the famous urban areas in Selangor. The CE method was a new approach in this field, and in Malaysia, so it was better to use personal interview as a data collection technique to make sure information given and gained was meaningful. With this technique, the interviewer could highlight and explain the questionnaire, the confidentiality, the purpose of the study, and CE questions. This process can produce high quality data. Thus, this kind of survey method was better than other data collection techniques. Due to time and cost limitations, this survey sample was obtained only 230 head of household of respondents.

4. EMPIRICAL FINDINGS

4.1 Demographic and Socio-economic Characteristics

Table 3 presents the results of the respondent demographic profile. As expected most respondents (62.6%) were male. The majority of respondents (56.4%) were relatively young, below 40 years old. The percentage of household size of the survey area were four to five person with 53.3% and majority (64.8%) were Malays. 44.3% of respondents had bachelor degree and 15.2% at least had a master degree. Nearly similar percentages of respondents were employed in government (36.9%) and private (36.5%) sectors and 22.2% involved in business. Monthly gross income figure were fairly high, 51.7% the income between RM6,001 to R10,000 and 23.9% had income above that level. However, majority (92.1%) the number of household had a job between 1 to 2 persons in their family and this situation is acceptable with a small family size since the study area is located in urban area.

Table 3: Descriptive Statistics for Respondents, *n=230*

Variable	Frequency (n=230)	Percent
Gender		
Male	144	62.61
Age		
Less than 20 year	3	1.30
21 - 30 year	45	19.57
31 - 40 year	82	35.65
41 - 50 year	67	29.13
5 1 - 60 year	27	11.74
More than 60 year	6	2.61
Household size		
2 person	20	8.70
3 person	36	15.65
4 person	63	27.39
5 person	60	26.09
6 person	37	16.09
More than 6 person	10	6.09
Race		
Malay	149	64.78
Chinese	59	25.65
Indian	11	4.78
Other	11	4.78
Occupations		
Government sector	85	36.96
Private sector	84	36.52
Business	51	22.17
Others	10	4.35
Education level		
Master and above	35	15.22
Bachelor	102	44.35
Diploma	32	13.91
Secondary school	61	26.52
Number of household have job		
None	6	2.61
1 person	77	33.48
2 person	135	58.70
3 person	3	1.30
4 person	3	1.30
5 and above	6	2.61
Monthly Gross Household Income		
Less than RM 2,000	6	2.61
RM 2,001 – RM 4,000	10	4.35
RM 4,001 – RM 6,000	40	17.39
RM 6,001 – RM 8,000	60	26.09
RM 8,001 – RM10,000	59	25.65
More than RM 10,001	55	23.91

4.2 The Choice Experiment

Table 2 presents the results of the conditional logit model regression analysis by listing parameter estimates and t value for each attribute levels used in the experiment. This CE was designed with three main water management policy options were present in each choice set. The overall coefficients and signs are as priori expected and correct positive signs except for *fair* in water quality attribute. This implies that the *fair* in

water quality level is closely related to base level, hence less favored by respondents. All coefficients for attribute levels are significant at the 1% level except for a price which significant at 10% level. The results indicate that the respondents prefers higher level than base level which the highest contribution to their utility.

Preferences of water interruption attribute levels showed a similar pattern. The condition in which the water service interruption *frequently happen* in a year is considered unacceptable, which further improvement is needed to over the current scenario resulted in increased preference. The consumer level of trust which related to quality of water supply either *high* or *medium* compared to *low* level in current scenario. Thus, respondents tended and prefers of safely drinking water.

Table 4: Results of the Condition al Logit Regression Estimates

Variable	Coefficient	*t* value
Water quality		
Very Good	2.988	5.996***
Fair	-.297	-1.226
Water Distortion		
Sometimes	1.519	6.809***
Never	2.724	5.675***
Trust		
High	4.255	15.199***
Medium	2.203	4.687***
Price	-.0300	-1.813*
N (Observations)	1150	
Log likelihood	-765.87	

The payment vehicle for domestic water service improvement simply uses an additional of water price with the current price of RM0.56 per cubic meter, measured as a percentage. The respondent is required to trade-off how much (in percent) he/she is willing to pay as an increase in the water price they pay with a varying mix of improved in water service attributes. The marginal rate of substitution (MRS) are estimated and reported in Table 5.

The marginal value for *very good* in water quality has a value of 99.5% and it implying that respondents is willing to pay almost double of water price with the level of water quality in relative to current water price. The value for *sometimes* and *never* happens of water interruptions was 50.6% and 90.7% respectively, over the current situation of *frequently happen* in a year. In terms of consumer trust on water quality supplied, the value for medium trust was 73.3% and high trust was nearly two times higher than medium ones of 141.7%. This implies that the respondents most preferred to have the highest quality of water supply to them are safe to be consumed directly from tap, without filtration and boiled.

Table 5: Marginal Rate of Substitution for Water Service Improvement

Variable	Conditional Logit, %[6]
Water quality	
Very Good	99.56*
Fair	-9.89
Water Distortion	
Sometimes	50.61**
Never	90.75***
Trust	
High	141.75**
Medium	73.38***

[6] The respondent is required to trade off how much (in percent) he or she is willing to pay for domestic water service improvement of current rate of RM0.57/m^3.

5. DISCUSSION AND CONCLUSION

This study has demonstrated how a questionnaire-based model of consumer preferences can improve public involvement in assists decision makers or domestic water supplier (SYABAS) improved water supply services. In addition, the used of CE is a feasible mechanism to analyse consumer preferences for water service improvements in Selangor, Malaysia.

The findings of the all water service improvement attributes provided strong evidence of significance and positive relationships of consumer's willingness to pay higher in water price in relative to current practice except *fair* in water quality attribute level. The implication of our study is that if decision maker or water service provider have decide to increased the water price, water service attribute levels preferred by consumer should be taking into consideration for consumer welfare. Then the model based on trade-off behaviour could clearly identify what the consumer preferred for their maximum satisfaction and fulfill their utility.

The above results also show that the CE provide an appropriate methodology for public assessments of trade-off the quantitative water service attributes such as water quality (WQ), water interruption (WI), consumer trust (QT) and water price (WP). In this study, a qualitative approach was adopted for the attributes and level used. Perhaps, in future, it may be necessary to employ a more quantitative approach then it will obtained and produced a better insights into consumer preferences for water service improvements.

The potential of choice experiments in Malaysia expecially in terms of domestic water services evaluation has not yet to be fully exploded. This study does take a step in the right direction. Marginal utility and willingness to pay were both elicited from the small sample population (n=230 respondents), the scope was limited then the findings was not impressive and comprehensive. It may be found that with a larger sample, other service factors and included quantitative variables may have to be used in future studies.

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